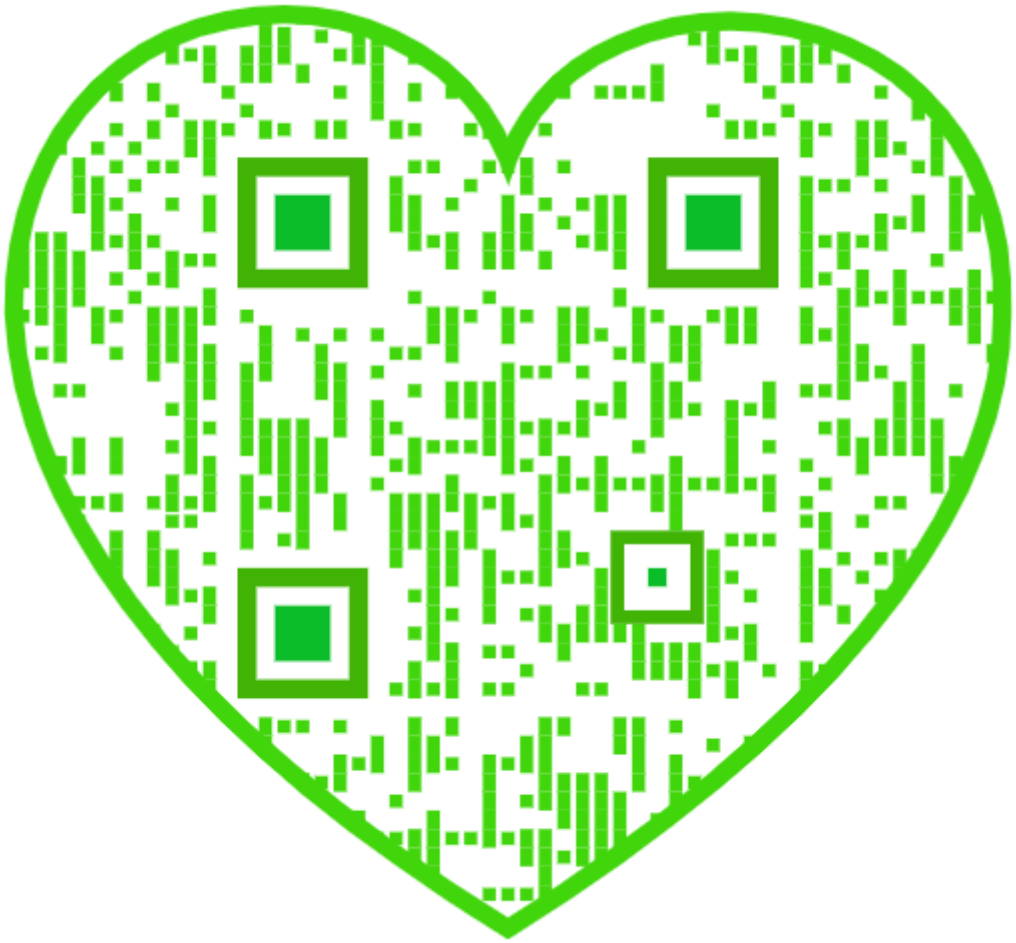
LIPPINCOTT'S FARM MANUALS

PRODUCTIVE SMALL FRUIT CULTURE

F. C. SEARS, M.S.



"The first farmer was the first man, and all historic nobility rests on possession and use of land."

—EMERSON.

LIPPINCOTT'S FARM MANUALS

EDITED BY

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PRODUCTIVE SMALL FRUIT CULTURE

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LIPPINCOTT'S FARM MANUALS

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LIPPINCOTT'S FARM MANUALS

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PRODUCTIVE SMALL FRUIT CULTURE

A DISCUSSION OF THE GROWING, HARVESTING, AND MARKETING OF STRAWBERRIES, RASPBERRIES, BLACKBERRIES, CURRANTS, GOOSEBERRIES AND GRAPES

BY

FRED COLEMAN SEARS, M.S.

(KANSAS STATE AGRICULTURAL COLLEGE)

PROFESSOR OF POMOLOGY, MASSACHUSETTS AGRICULTURAL COLLEGE

196 ILLUSTRATIONS IN THE TEXT

"If vain our toil,
We ought to blame the culture, not the soil."
POPE—*Essay on Man*

PHILADELPHIA & LONDON

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To My Father
THOMAS BARTLETT SEARS
WHO TAUGHT ME THE DETAILS OF PRACTICAL AND EFFICIENT FARMING, THIS BOOK IS AFFECTIONATELY DEDICATED

Fred Coleman Sears

10425

PREFACE

The following discussions on small fruit culture have been drawn from many sources. They have grown in part out of my experience in the growing of these fruits in the Department of Pomology of the Massachusetts Agricultural College and in various other institutions where I have had these plantations in charge; they have come partly from work with college classes where such subjects have been under consideration; another and very important part has been drawn from association with the practical fruit growers of the country, than whom there are no better instructors to be found in the world; and a relatively small but very important part has been drawn from personal experience in growing these fruits in my own garden and on my own farm.

The discussions are offered to the fruit-growing fraternity for what they are worth. This may be much, or little, or nothing, depending on the one who consults the book. Two principal aims have been kept in mind in the preparation of both the text and the illustrations: first, to have them clear and concise so that they might be readily understood; and, second, to include only such matter as had been fully tested and had proved of actual, practical value.

It is my hope that two classes of people in particular may find the book of real value, *viz.*, first, the instructor who is conducting classes in small fruit culture (and possibly his students), who may find new points of view presented and perhaps old ones more fully explained; and, second, the practical grower who has not yet mastered all the details of the business, but who wants suggestions on some of the many points which are constantly coming up for decision on any fruit farm.

The practice work given in the Appendix will suggest many other lines of planting, pruning, transplanting, spraying, plant selection, inspection, harvesting, marketing, etc.

I wish to acknowledge my indebtedness to all who have

helped in the preparation of either the text or the illustrations. These helpers have been many, and they are all gratefully remembered, though they cannot all be personally mentioned.

The illustrations are principally from photographs which I have myself taken, generally for the special purpose of using them in this book; I am indebted, however, to Mr. J. L. Stahl, of the Experiment Station at Puyallup, Washington, for many photographs which have been used and for many helpful suggestions. The drawings in the book are all made by my sister, Miss Kate B. Sears, of Lawrence, Kansas.

I am especially indebted to Mr. George M. Darrow, of the Bureau of Plant Industry, U. S. Department of Agriculture, a recognized authority on small fruits, who has read the entire manuscript and offered many valuable suggestions; and lastly to my editor, Prof. K. C. Davis, for many suggestions and criticisms and much assistance in the somewhat trying details of getting the book into print.

Fred C. Sears.

Massachusetts Agricultural College, Amherst.
January, 1920.

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PRODUCTIVE SMALL FRUIT CULTURE

CHAPTER I

SELECTION OF SITES

Barring general neglect by the owner, no factor is more frequently responsible for the failure of a small fruit plantation than trying to grow it in the wrong place. Too dry a soil cuts off the yield of a strawberry crop; too wet a soil causes winter injury in the raspberry block; too low and flat a site leads to a blighting of the blossoms of the strawberry patch in the spring, or to the loss of the grape crop in the autumn, through frost damage; too windy a location dries out the soil and injures the crop of most of the fruits under consideration.

Since the present treatise does not deal with the desirable and undesirable points in the *owners* of small fruit plantations, it seems best to begin this general discussion with a consideration of this second most important factor in the success of the plantation, the site.

As ordinarily sub-divided, the following are the features of the site or location which ought to be considered:

The Slope of the Land.—This influences the plantation along three different and important lines, namely, in relation to the sun, to winds, and to atmospheric drainage. If the slope is southerly the plantation will receive more heat from the sun, which may or may not be desirable. In any fruits which are not likely to mature through lack of a sufficient number of heat units during the growing season, or in case early fruit is desired to catch the high prices which may prevail at the beginning of the season, it is, of course, very desirable to get all the heat possible, and a southern slope is greatly to be preferred. It is surprising, too, how slight a slope will help materially in increasing the heat, and thus hastening the maturity of a crop.

On the other hand, where a cool location is desired, as is the

case with a number of the fruits under discussion, a northern slope is very desirable, and even a slight slope to the south is to be avoided if possible (Fig. 1).

Air Drainage.—The slope is also very important on account of its influence on atmospheric drainage and through that on the occurrence of and damage from frosts and freezes. It is a well-known fact that cold air is heavier than warm air, and this leads to currents of air down the slope when the wind does not blow and keep the temperature of the air uniform. On quiet nights, therefore, the cold air flows down the slope, just as water might,

FIG. 1.—One type of good country for small fruits. The higher lands are admirable for grapes and currants and the lower for strawberries, raspberries and blackberries.

and settles on the level land at the bottom, often producing a frost on these lower fields when there is none above. It is surprising, too, how slight a difference in level will determine whether a frost occurs or not. It is not uncommon to see a corn field or a bean field with one corner badly frosted, while on adjoining parts of the field, not more than five feet higher, no frost has occurred. Moreover, the greater the territory above a particular field from which the cold air drains down on that field, the greater the chance of frosts occurring on that field, since it not only receives its own share of the cold air, but that from the large area on the slopes above. This accounts for the

fact that frosts are so likely to occur on the valley or bottom lands in sections where there are high hills and narrow valleys.

Not only is the slope important in relation to frosts, but it also exerts a decided influence on the more severe temperatures which occur during the winter. It is a well-known fact that in peach growing, for example, the fruit buds may come through the winter unharmed on a block of orchard on elevated land, while in a nearby block on low land every fruit bud may be killed, due to the much lower temperatures reached on these lower levels from the settling of the cold air. In the same way any of the small fruits which are liable to winter injury may be severely injured in one location and escape entirely in an adjoining field, the difference due altogether to this atmospheric drainage.

Exposure to Winds.—A third phase of the slope question, though it is a much less important one with the fruits under discussion than with orchard fruits, is the question of winds. This is less important with small fruits than the other two phases already discussed. They are likely to damage a small fruit plantation principally in two ways, by drying out the soil during the growing season, and by increasing winter injury through the drying out of the canes during periods of severe cold in winter. In those sections where dry weather is likely to prevail to a sufficient extent to cause damage one ought, therefore, to select slopes which are not towards the prevailing summer winds; while in sections where winter injury is to be feared northern and northwestern slopes should be avoided. Damage to the fruit on the vines is a less serious matter with these fruits than with the orchard fruits, but even this phase of the question deserves consideration, especially in sections where severe winds are likely to prevail during the growing season. The blossoms are likely to be injured, or the fruit itself damaged, or the young and tender foliage may be hurt by strong and especially by dry winds.

Windbreaks.—While this question of the influence of slope on wind injury is under discussion, it may be well to add here that in those sections where winds are strong and are likely to

do damage to the plantation, windbreaks are very desirable, even though a site has been selected on land which slopes away from the wind. For this purpose, one should, of course, select trees which first of all will be successful in his section, but also those trees which do not harbor either insect or fungous enemies which are likely to infest the plantation. Just at the present time the white pine would be excluded from all windbreaks for currant or gooseberry plantations, because of the blister rust which passes a part of its life cycle on the white pine, and a part on the currant or gooseberry. All things considered, the hemlock and the spruces among evergreens, and the maples among deciduous trees, are probably the most generally satisfactory for windbreaks.

Proper Soil.—The second general factor of the site question is the soil, and an extremely important factor it is, too. One ought to study the local soils and to understand as fully as possible the advantages and disadvantages of the different types of soil, before locating the plantation. Experts classify soils roughly as sands, silts and clays, according to the fineness and composition of the soil particles. These three general classes, of course, shade gradually into each other, and are always more or less mixed, so that we have a wide range of types varying slightly from each other in their characters and in their effects on crops.

Sandy Soils.—It is not the province of the present treatise to go exhaustively into this question, but it may be said briefly that sandy soils possess the great advantage of being warm and consequently starting their plants into growth early in the spring. They are also easy to work and are not easily damaged in texture. And they respond very quickly to any treatment with fertilizers. On the other hand, they quickly lose their humus content, and suffer thereby from the effects of drought. They would, therefore, be especially valuable where earliness and quick growth are desired, but should not be used, or if used should be handled with especial care in cultivation and in keeping up the humus content, where an abundance of soil moisture is important.

Soils Rich in Clay.—Clays, on the other hand, are nearly at the opposite extreme in most of the characters noted. They are very retentive of moisture, of fertilizers, and of humus, but are comparatively cold, and their texture is easily damaged if they are worked when too wet. And because they dry out so slowly, there is always an added temptation to get on them for plowing or cultivating before they are really in the best condition for the work. It requires a good deal of fortitude to sit idly by and see the neighbors getting their season's work started while one waits for his own heavier soil to get into proper condition for working.

A Temperature Factor.—One reason for this difference in the rate of warming up in clays and sands is the water content, and in this connection the following quotation from Prof. F. H. King's book, "The Soil," is of interest:

"There is no one cause so effective in holding the temperature of a soil down as the water which it contains, and which may be evaporating from its surface. This is because more work must be done to raise the temperature of one pound of water through one degree than of almost any other substance. Thus, while 100 units of heat must be used to raise 100 pounds of water from 32 to 33 degrees F., only 19.09 units, according to R. Ulrich, are required to warm the same weight of dry sand, and 22.43 units an equal weight of pure clay, through the same range of temperature. To raise the temperature of 100 pounds of dry humus through one degree, it is necessary to give to it 44.31 heat units, while 100 pounds of carbonate of lime require 20.82 units.

"From these figures it is evident that when the sun imparts equivalent amounts of heat to equal amounts of sand, clay, humus, and water, the sand will be the warmest, while the water will be the coldest. To make the differences definite, suppose the water has its temperature raised ten degrees, then the same amount of heat entering an equal weight of humus will make it 22.06 degrees warmer, clay 44.58 degrees, and sand 52.38 degrees warmer. But while the temperatures of these soils would stand in the relation of the figures here given when they are

dry, it is not true that under field conditions such large differences of temperature would be observed, because there are other factors which modify the effect of differences of specific heat, whose influence alone we have thus far considered."

Some Intermediate Soils.—Heavy clays ought probably to be avoided for all of the fruits under consideration; but the lighter types, such as light clay loams, or medium clay loams, if handled properly and kept well supplied with humus, are very satisfactory for those fruits where earliness is not imperative and where an abundance of moisture is important.

The silty soils are intermediate in characters between the sands and clays, and are very satisfactory types for most of the small fruits.

The Humus Supply.—Before leaving this matter of soils, some further emphasis ought to be placed upon the question of keeping up an abundant supply of humus in all soils used for small fruits. With the possible exception of the grape, few crops suffer more from a lack of humus than those under discussion in this treatise. This, of course, is largely because few crops are more dependent on soil moisture, but besides being extremely important in holding a supply of moisture in the soil, humus improves the physical condition of all soils, but especially the two extremes, clays and sands, and it adds materially to the fertility of the soil. An especial effort ought therefore to be made to supply soils used for the small fruits with humus through the use of barnyard manure, if that can be had, and also by growing and plowing under just as much vegetable material as possible. It is even considered wise with some of the fruits under consideration to devote an entire season to growing and plowing under successive crops of one kind and another in order to make sure of a high humus content in the soil.

Water Drainage.—A last factor of the site question, though one very intimately connected with some aspects of it which have already been discussed, is the question of water drainage. There ought always to be slope enough to carry off all surface water, for none of the small fruits will thrive where there is a likelihood of water standing for any length of time. And the

subsoil must be light enough naturally, or must be drained artificially, so that the soil will not be too wet. A wet soil is always relatively cold, and there is almost certain to be more winter injury to plants growing on it than will be found on better-drained and drier soils. On the other hand, too much drainage, either surface or sub-drainage, ought to be avoided. The former causes not only the loss of soil fertility and even the soil itself, but also the loss of needed soil moisture; while if the sub-drainage is too great, it produces too dry a soil.

QUESTIONS

1. In what ways does the slope of the land affect a small fruit plantation?
2. Have you ever seen bad effects from atmospheric drainage? Describe them.
3. What are the worst winds in your section? Have you seen examples of the injurious effects of winds?
4. What types of soil do you have on your farm? Which do you like best?
5. What is humus? How does it affect soils?
6. How are clay soils better than sandy soils?
7. In what ways are they more difficult to handle?
8. How is the temperature of the soil influenced?
9. Have you ever seen bad effects from poor drainage in the soil?

CHAPTER II

IMPLEMENTS

It rarely happens that it is necessary to buy special implements for use in the small fruit plantations on the average farm. If small fruit growing is the only, or the principal, line of farming, then the equipment is likely to be somewhat different from that on the general farm, but it is possible to get along very well with only those implements in common use.

On the other hand, it is often possible to slightly vary the implement bought, if one is to use it in the small fruits, and in any event it seems worth while to discuss briefly, in this present chapter, the general question of implements, with especial reference to those needed for work on the small fruit plantation.

Plows.—Beginning with plows, two or perhaps three types will be found useful. For the work of plowing in preparation for the plantation almost any good plow will be satisfactory, but since it is desirable to plow deeply and to pulverize all the soil which is turned over, a large plow with an abrupt mold-board will do the work most satisfactorily. A twelve-inch plow is as small as will do the work in the most acceptable manner. This plow may be either an ordinary walking plow, or a double sulky, or a side hill plow, without making any great difference in the work done, except that the last two named will leave no dead furrows nor back furrows, and are to be preferred somewhat on that account.

For fitting the land after the plantations have been established, the problem is quite different. One then wants an implement that will get over the plantation quickly, getting close to the rows and not stirring the soil very deeply, and if a plow is to be used, nothing is better than the little three-bottom-gang plow shown in figure 2. It will cover a width of twenty-four inches, will easily go to a depth of five inches (which is deeper than one generally cares to go in this work), and will work

very close to the rows. In addition, the draft is very light, being no more, certainly, than the average fourteen-inch walking plow.

Harrows.—Of harrows there is an endless variety, adapted to every possible condition that can arise.

FIG. 2.—A three-gang plow. Three eight-inch plows with a draft not greater than a single 14-inch plow. A splendid implement for work among small fruits.

FIG. 3.—Cut-away type of disk harrow. One of the best implements to follow the plow. The first time over it should always be run in the same direction as the plowing.

Disk Harrows.—In farming operations the disk types come first and are among the most indispensable of all implements. The one shown in figure 3 is the cut-away type, with the edges of the disks cut into notches. This is supposed to make the

implement cut more deeply into the soil than the other type which has smooth edges to the disks; either one, however, is very effective, whether it is used following the plow as shown, or as a substitute for the plow, as is often done in small fruit plantations in the spring fitting of the land. When this implement is used to follow the plow it should always be first run in the same direction as the plow, as there is then much less tendency to turn back the furrow slice and expose the sods or trash that may have been plowed under.

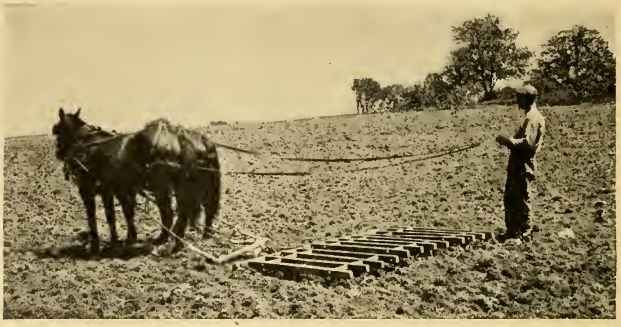

FIG. 4.—Smoothing harrow. Excellent to follow a disk or spring-tooth harrow in fitting land.

It is an admirable implement for stirring the soil deeply at any time and will be found especially useful when in the rush of work the weeds have made such a start that other harrows and cultivators will not handle them.

Spring-tooth Harrow.—Next to the disk, both in its capacity to stir things up, and in the sequence of fitting the land, stands the spring-tooth harrow, which is an admirable implement. Its especial value lies in its tendency to dig down into the soil and stir it thoroughly, loosening it to a considerable depth. Its weakness lies in the fact that this very type of work tends to pull out of the soil any trash or sods, and leave them on the surface. It ought, therefore, to be used with judgment and not put onto land which is very trashy or soddy until the soil has been

so worked down after plowing that the danger of pulling out refuse material is relatively small.

Smoothing Harrows.—Following the spring-tooth harrow, we have the spike-toothed smoothing harrow shown in figure 4. The name indicates its effect. Some types have a lever by the use of which the teeth can be set at any angle desired. The one shown is a somewhat older type which has slanting teeth when

FIG. 5.—Acme harrow. An excellent finishing implement where there are no stones nor sods.

attached as shown. It has perpendicular teeth when the sections are attached to the evener by the other end. It is one of the oldest types of harrows, is found on almost every farm, and is very efficient when conditions are right. It will not do good work where there is much trash, or where the weeds are at all large.

The Acme harrow shown in figure 5 will admit of still less trash and weeds and yet do good work. But when conditions are favorable, with no trash and very small weeds, it does most excellent work. Its action is a combination of cutting and crushing, the teeth starting with the broad dimension in a horizontal position, which crushes the clods, and gradually turning so as to assume a vertical position which gives them a cutting effect.

The Meeker harrow shown in figure 6 is a special type used most frequently by market gardeners. It consists, as may be seen, of two double gangs of flat, sharp-edged disks, which chop up the soil, at the same time leveling it down. While it will not pay, probably, to buy one especially for the small fruit plantations unless they form a very important part of the farm work, yet it is a most effective implement for putting the finishing touches on a block of land that is being prepared for setting.

Brush Harrows.—The last type of harrow to be included in this discussion is the brush harrow shown in figure 7. This is a

FIG. 6.—Meeker harrow with two double gangs of sharp-edged disks. A fine implement for cutting up sods or any type of lumpy soil.

home-made affair, but none the less useful, and considerably less expensive on that account. It is made by boring holes with an auger (preferably a two-inch bit) into a plank about eight feet long and six inches wide by two or three inches in thickness. Brush from ten to fifteen feet in length is then cut, and the butt of each sapling is smoothed down so as to fit into the hole in the plank. It is then driven in tightly and nailed in place with one or two wire nails. The double-tree is attached to this plank by a short chain. The plank itself levels down any irregularities that there may be in the surface, and then the brush, following, assists in this leveling process, pulverizes the surface soil, rolls over and over any sods which may be on the surface and thoroughly works them up. As a finisher it is certainly a most excellent implement.

Planker.—Another home-made implement which is very useful and quite inexpensive is the planker, or clod-crusher, shown in figure 8. Its construction is easily seen from the illustration.

FIG. 7.—Brush harrow. A home-made implement but very useful in finishing the preparation of the land.

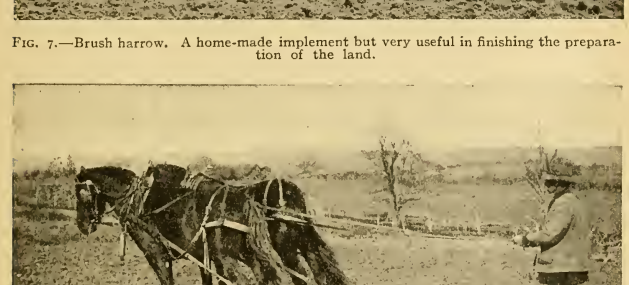

FIG. 8.—A planker or clod crusher. A home-made implement that is ideal for finishing off a block of land before setting.

Three or four planks are used, ten or twelve inches wide and the desired length, usually seven or eight feet. These are lapped together shingle fashion, as shown, and nailed in place with heavy wire nails where each plank meets the one behind it. Additional strength is given by the cross-pieces which are nailed or bolted

in place. An improvement on the one shown can be made by notching the cross-pieces to fit the planks and bolting them in place. The effect of the planker on the soil is three-fold: first,

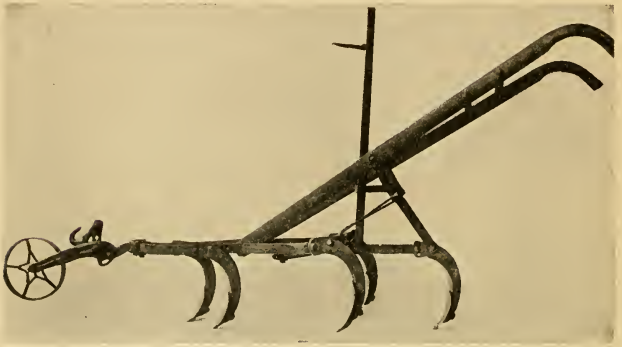

FIG. 9.—V-shaped cultivator with five rather large teeth or shovels. This type of cultivator is especially valuable where the weeds have gotten a start in the plantation.

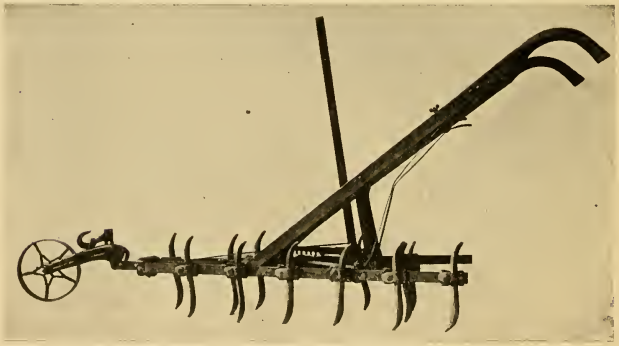

FIG. 10.—V-shaped cultivator with spike teeth. This is an admirable implement where soil conditions are good and there are no large weeds in the plantation.

it levels the surface; second, it breaks up the clods; and third, it compacts the soil. In the writer's opinion, it is usually to be preferred to a roller, since it has a much greater tendency to

move the soil from high spots into low ones, and its action is to grind up the clods instead of merely pressing them into the soil. It leaves a light mulch over much of the surface.

Cultivators.—Turning now to various kinds of cultivators, the ones in most common use in small fruit plantations are the one-horse, V-shaped types shown in figures 9 and 10. To be really well equipped, there should be at least two kinds of these on the place; one with large shovels for larger weeds or rougher conditions of soil, and one with small, spike teeth for

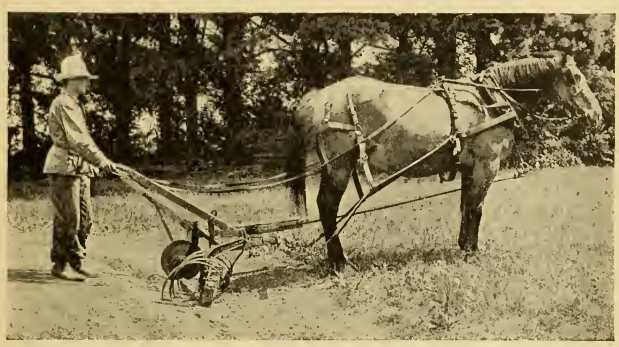

FIG. 11.—Grape hoe; a very useful implement for work along the rows of grapes, raspberries and other fruits.

maintaining a shallow mulch when conditions of soil and weeds are more favorable.

In the few cases where the rows are far enough apart to admit of the use of two-horse cultivators some kind of spring-tooth implement will generally be best.

A special type of cultivator is the grape hoe shown in figure 11. It is intended for use close to the row, either by the side of or between the plants, and its use will, to a very large extent, do away with the necessity for hand labor. It has two attachments, one a curved steel affair, somewhat like the mold-board of a plow which is designed for use under conditions where a plow would be desirable; that is, in the spring to finish out

what the plow cannot reach along the row, or later on if the weeds get too much start. The second attachment is that shown in figure 11, a number of spring teeth for cultivation close to the plants.

Two types of fertilizer sowers are likely to be needed. One is the horse-drawn implement shown in figure 12, which will be useful in applying fertilizer before the plantation is set, in case this is considered best, or for use among the bush fruits or in vineyards where the rows are far enough apart to admit it. The

FIG. 12.—Applying lime with a horse-drawn fertilizer sower. An excellent machine for use on the land before the plantation is set.

other type is the hand or man-power distributor shown in figure 13, which is particularly valuable with strawberries, but may be used with many of the other small fruits. Since these fruits are likely to be highly fertilized some expeditious method of applying the material is very desirable.

Hoes.—It may not be out of place to close this discussion of implements with a word on hand hoes, since they are sure to be used to a greater or less extent in most of the plantations under consideration.

Two types will be found especially valuable for small fruits. One is the broad, shallow type of the ordinary hoe shown second

from the left in figure 14. This is for use where the weeds are large enough to need cutting off, and is greatly preferred to the narrow and deep type shown at the extreme right, because it covers more ground, and gives a shallower mulch, while being just as effective in cutting weeds.

The second type of hoe that will be found useful is that shown second from the right in figure 14. As will be seen, it

FIG. 13.—A hand fertilizer distributor. Delivery may be concentrated or scattered by moving the tubes.

has a divided blade, being really a narrow rake with wide, flat teeth. Its especial advantage is the ease with which the work of hoeing can be done. To one who has never used it the difference will certainly be surprising, and it is just as effective as an ordinary hoe unless there are weeds of some size. For the man who keeps ahead of his work it is certainly a labor-saver.

A Good File.—With any hoe, but more especially with the ordinary type, a regular part of the operator's equipment ought

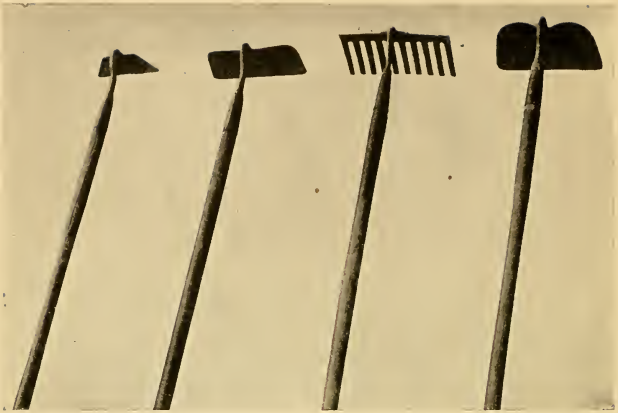

FIG. 14.—Types of hand hoes. The one at the extreme left is especially useful in working among plants in a renovated strawberry bed. Two central ones are the most generally useful.

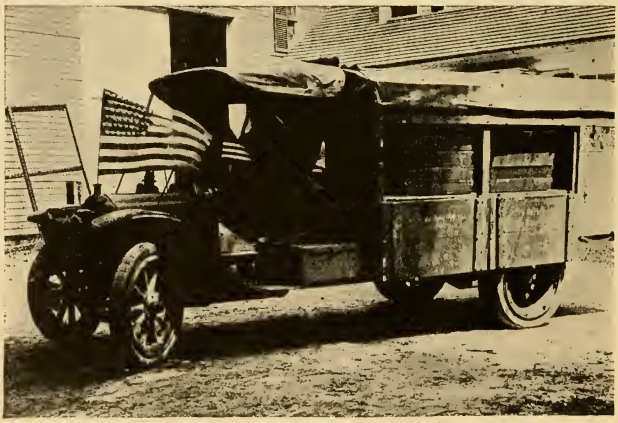

FIG. 15.—A market truck with special closed body for transporting berries. It will carry one crate or one hundred in equally good condition.

to be a good file. Few people realize what a difference there is in the energy required to propel a sharp hoe and that necessary to run one with an edge like a board.

Auto Truck.—While not strictly an implement, some type of auto truck will be found of great value for markets within a distance of ten or even twenty miles, and may be used on much longer hauls. The one shown in figure 15 was designed especially for delivering strawberries in markets from four to fifteen miles distant.

QUESTIONS

1. What kinds of plows have you seen used? What kinds are most common in your section?
2. What do you think is the best type of plow?
3. Describe the disk harrow and its effect on the soil.
4. How many types of implements have you seen with the kind of tooth known as "spring teeth"?
5. What is the effect of this kind of implement on the soil?
6. Describe the smoothing harrow.
7. The Acme harrow.
8. Did you ever see a Meeker harrow in use? What is its effect on the soil?
9. Did you ever see a bush harrow in use? Do you think it is a good implement?
10. Describe the planker and its effect on the soil.
11. What is a grape hoe?
12. What kinds of cultivators have you seen in use?
13. Describe a fertilizer sower.
14. What kinds of hand hoes have you seen used? What kind do you think best?

CHAPTER III

FERTILIZERS

The practice of using commercial fertilizers in farming has undergone a great development in the past twenty-five years. In sections which a quarter of a century ago used no chemical fertilizers whatever, and on soils which were then considered to possess inexhaustible fertility, the practice of supplementing the plant food in the soil and that available from barn manure with various types and quantities of chemicals is now a regular and well-established one.

The small fruit industry has shared in this change, and while we still find sections where little or no special fertilizer is used, yet in most sections and with most of these fruits the fertilizer problem has become an important one, and, as a rule, large quantities are used.

It seems worth while, therefore, to present in this general discussion a brief statement of the fertilizer problem, of the effects of different plant foods, and of the most common forms of fertilizers in use among small fruit growers.

Shall We Fertilize?—The general question of whether fertilizers ought to be used on small fruit plantations or not is in much the same phase of development as it is with other fruits, *viz.,* some authorities say "Yes," others "No." Some growers use fertilizers heavily and others not at all. Doubtless this variation in opinion and practice is due in considerable part to differences in soil and climate, but also to differences in pruning and other care, and perhaps still more to a difference in knowledge of the case.

If fertilizers are to be used, which question is discussed more in detail in the sections devoted to the special fruits, then one ought to know as much as possible of the specific effects of the various fertilizers, and to this question we may now turn our attention.

Needed Elements.—It is a common statement, and reason-

ably accurate, that of the many chemical elements found in the soil and used by plants in their growth, only three or four are ever likely to become so depleted as to need to be returned to the soil. These four are nitrogen, phosphoric acid, potash and lime.

Effects of Nitrogen.—Nitrogen is the most easily lost, the most popular and generally used by growers of all the plant foods, and its effects are perhaps most pronounced and best understood. It is usually stated that nitrogen is conducive to vegetative growth as distinguished from fruit bearing, and it is considered more necessary with those plants, like hay or lettuce, where the leaves, and not the fruits or seeds, are the parts used as food. But since a good development of leaf surface is a necessary prerequisite to a satisfactory fruit development, a certain and generally a liberal amount of nitrogen fertilizer is needed in fruits.

To be a little more specific, a generous supply of available nitrogen in the soil will produce the following effects:

1. It will give a dark green color to the leaves. Even those leaves which were put out before the nitrogen was applied will become a deep shade of green as soon as the nitrogen has had time to act, and this is a very short period with the quick-acting forms, like nitrate of soda, provided there are rains to dissolve them and wash them into the soil.

2. The leaves produced by the plant which has an abundant supply of nitrogen will be large, much larger than where the nitrogen is deficient.

3. There will be a rapid and abundant extension of the branches on the plant.

4. The period of growth will be prolonged, a fact which must be considered carefully, and an excess of growth guarded against, if winter injury to the canes is to be avoided.

5. The maturity of the fruit will be retarded.

6. The fruit will be larger and softer in texture.

These are all important effects and they are sufficiently varied so that the use of nitrogen, and the various forms of it, ought to be very carefully studied and even experimented with by the fruit grower, before he uses them too freely.

Effects of Potash.—Potash is much less generally used and its effects are less marked and less understood. It is known that it has an important part in the synthesis or building up of carbohydrates, such as sugar and starch, not entering directly into their composition, but its presence being necessary in order that they may be built up in the tissues. It plays a similar part in the formation of proteins. Also it is known to enter into the acids of fruits, to be present in large quantities in pollen grains, and to be an important part of the ash of fruits (showing that it has been freely used by the plants in their development). For all of these reasons some form of potash is rightly considered a very important plant food and is generally included in the fertilizer formula applied to small fruit plantations.

Effects of Phosphoric Acid.—Phosphoric acid is used to about the same extent that potash is, so far as the number of growers using it is concerned, and in considerably larger amounts by the individual growers. It is credited with controlling the growth of plants, checking the tendency to undue and prolonged growth, and is therefore popular where winter injury is likely to occur. It is also important in the development of the seed and, in fact, in any cell growth. Since seed development is very closely associated with fruit development this side of the question is doubtless of importance even though we consider the seed a negligible and even an objectionable part of the fruit.

Effects of Lime.—Lime is generally included in the substances applied to the soil more as an amendment (to correct acidity or on account of its effect on the physical character of the soil) than because it is thought to be needed as a direct plant food. But it is generally considered by scientific investigators to assist in the formation of cell walls, to be necessary, therefore, for a good leaf development and to assist in the transportation of starch from one part of the plant to another. It also forms an important part of the ash of plants, showing that it has been used abundantly.

Turning now to specific forms of fertilizers we have the following that are in common use:

Nitrate of Soda.—Among nitrogenous fertilizers nitrate of

soda is by far the most popular. Its most conspicuous characteristic is the rapidity with which it becomes available. Fruit plants to which it is applied will show a change in the color of their leaves within a week and will often show a decided improvement in growth within two weeks provided the nitrate is cultivated into the soil so that it can come in contact with soil moisture and so dissolve, or provided there is rain to dissolve it and carry it into the soil. This rapidity of action has its good and its bad sides. On the one hand, it enables the grower to come to the rescue quickly when his plantation shows poor growth from winter injury, or from any other cause; and on the other, the effects of the fertilizer are quickly dissipated and need to be supplemented by another application of this fertilizer or by the use, along with this, of some more slowly acting material. Nitrate of soda is also, as a rule, one of the cheapest forms in which nitrogen can be purchased and there is less chance of its being adulterated.

Tankage is a by-product from slaughter houses, containing blood, bone and various other refuse in a finely ground condition. It is strongest on the nitrogen side, but contains considerable phosphoric acid and some potash. Its nitrogen is slowly available and a combination of this with nitrate of soda will give excellent results in the way of a long-continued and steady growth.

Nitrate of lime, or "Cyanamid," is another good form and is being more and more used. It is a manufactured form, made by combining the nitrogen of the air with lime, and ought some day to be cheap enough to revolutionize farming. Its effects and peculiarities have not been as fully determined as those of nitrate of soda, but in general it is somewhat comparable to that material.

Sulfate of ammonia is another slowly acting form of nitrogen which combines well, in effect, with one of the more quickly acting types.

Acid Phosphate.—Among phosphoric acid fertilizers, acid phosphate is perhaps in most common use with small fruits. It is a manufactured article, being made from either rock phos-

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phates or bone meal by treating them with sulfuric acid in order to render the phosphoric acid more soluble and hence more quickly available.

Bone meal is another very popular form, but is not so readily available. If the best results are to be secured in the growth of plants probably some acid phosphate and some bone meal ought to be included in the formula, the former for immediate use and the latter for later use by the plant.

Basic slag is a third form of phosphoric acid and has about the same availability as bone meal.

Forms of Potash.—Of potash in normal times, two forms have been in use, the muriate and the sulfate. There seems to be little difference in their popularity. Muriate is usually somewhat cheaper, while there is some evidence to show that the sulfate has a tendency to reduce the likelihood of winter injury. Muriate also has a tendency to make the soil sour by taking out of it the lime content. This is caused by the chemical changes going on in the soil by which the hydrochloric acid of the muriate of potash combines with lime, forming chloride of lime which is soluble and likely to pass out of the soil with the drainage water.

Use of Lime.—Lime has been mentioned as one of the substances which may be needed and it is occasionally used with small fruits, but, with the exception of grapes, it is seldom used directly upon the fruit crop. It *is* used in preparing a block for these fruits in order to get a satisfactory growth of some crop to plow under. But since these fruits either seem indifferent to acidity of the soil, or actually to prefer such a soil, it is not considered good practice to use lime on them directly.

Two other fertilizing materials ought to be mentioned in this discussion, though they are not classified with any of the three types discussed. These are barnyard manure and wood ashes.

Barnyard manure is an unbalanced complete fertilizer, which is very strong on the nitrogen side. If precautions are taken to supplement it with chemical or commercial fertilizers in order to balance up the formula there is nothing so conducive

to success with most small fruits as the use of some barnyard manure. Its effect is shown along two lines. In the first place, as already suggested, it carries a large amount of nitrogen, some of it very readily available and some more slowly, so that we may expect the effects already discussed under nitrogen. In the second place, it carries, of course, a large amount of vegetable material which quickly forms humus, so that we get the benefits which come from that material, *viz.*, holding moisture and improving the physical condition of the soil.

There is little question in the writer's mind that it is possible to bring along a small-fruit plantation a little more satisfactorily if some barnyard manure can be used, than can be done in any other way. With plenty of commercial fertilizers, and with an abundance of large growing crops plowed under, it may be possible to fairly closely approximate the results of barnyard manure.

Wood ashes, especially those from hard wood, are an excellent fertilizing material for these fruits. They are particularly strong in potash and lime, but carry more or less of some other mineral elements, and their use is to be commended if a good grade of ashes, one that has not had the potash leached out of it, can be secured.

Applying Fertilizers.—Fertilizers are best applied by some machine or distributor where plantations of any size are to be handled. The two types of machines shown in figures 12 and 13 will be found admirable. In most cases it is considered best to apply at least a part of the fertilizer which is to be used the year of setting, after the plants have been set. A part of it may be put on beforehand, but, particularly with nitrogen, there is likely to be some loss if the fertilizer is all put on in the operation of fitting the land before setting.

Fertilizers applied to established fruit plantations (that is, in seasons after the year of setting) are generally applied fairly early in the spring. If insoluble materials are used, like bone meal or slag, it is desirable to get them on either before plowing or very soon after it, so that the working of the soil may incorporate them thoroughly with it. If this is not done, the fer-

tilizers being applied after all the fitting of the land has been done, then there is only the subsequent cultivation to work them into the soil and we do not derive as much benefit that season from the fertilizer as we should.

QUESTIONS

1. Why do some fertilizing elements in the soil become exhausted?
2. Why do others not become exhausted?
3. What do you consider the most important effect of soil nitrogen on the growth of plants?
4. Have you ever seen such an effect?
5. How does potash affect the growth of plants?
6. Have you ever seen the effects of phosphoric acid on plant growth?
7. Is lime useful to plants? In what ways?
8. Describe the effects of nitrate of soda.
9. What is tankage? When would you use it?
10. What is cyanamid? Where and how is it made?
11. What are the most valuable points of barnyard manure as a fertilizer?
12. Have you ever seen effects on crops from using wood ashes? What were they?

CHAPTER IV

COMPANION CROPS

The term companion crop is generally accepted to mean one which is grown along with another more important and usually more permanent crop. As used in the discussion here it would certainly have both of these characteristics, a transient and relatively unimportant crop, yet often a very useful one, a "pot-boiler," to borrow an expression from the artist's profession.

But while the companion crop is relatively unimportant, when compared with the fruit crop, still it holds a very significant place in the fruit industry, and there is no branch of farming, with the possible exception of vegetable gardening, where the companion crop is more commonly or more successfully used than in fruit growing.

With the fruits under discussion in this volume, it is relatively less important than with the tree fruits, because these latter are long-time fruits, which are placed wide apart and take a number of years to reach their full size, thus giving, from one standpoint at least, the ideal conditions for the introduction of the companion or inter-crop. Still, even with the fruits at present under discussion, it is often deemed advisable to inter-crop the plantation, and it certainly seems worth while to consider briefly the arguments *pro* and *con* on the question.

Objects.—Of course, the primary consideration which usually determines a grower of small fruits to use some companion crop with his raspberries, or his currants, or his grapes, is the idea that it is going to pay the expenses of the plantation while it is becoming established and getting into bearing. If it accomplishes this object it, to a considerable degree, justifies the venture.

Two very important considerations ought to be kept constantly in mind here, and these are, first, that the companion crop may *not* pay a profit, and, second, that even though it does prove profitable in itself, it may entail so much extra work to keep the fruit plantation in proper condition, or may so retard

or injure its growth, that any financial benefit from the companion crop of beans or potatoes may be more than offset by the damage to the permanent fruit crop of raspberries or grapes.

Shall There be a Companion Crop?—Like most questions in fruit growing, or in any other profession, for that matter, this one of companion crops will depend largely on the personal, local conditions which belong to the special plantation under consideration. But in order to assist the prospective fruit grower to decide the matter it may be well to introduce here, very briefly, the affirmative and negative arguments on the question.

Arguments for Companion Crops.—Taking first those arguments which favor the companion crop, we have the following:

1. As already suggested, the idea that it will pay the expenses of the fruit plantation until it comes into bearing. If this is true it is certainly an important point. But one ought to be reasonably sure that it will turn out so in his own particular case before he embarks on the venture. Because Jones, a professional market gardener, makes 500 dollars an acre on cabbage grown under his conditions, it does not follow by any means that Brown, a fruit grower (and perhaps not a professional at that) can do the same with cabbages planted among his currants. Moreover, the need of a companion crop in a small fruit plantation is by no means as acute as it is in an apple orchard. With the latter the owner must usually wait anywhere from six to twelve years before he can expect a profitable income, while with the small fruits it is seldom over three years, and with strawberries only one year, before the maximum returns are reached.

2. A second benefit which may come to the small fruit plantation from the companion crop is more thorough cultivation. While this may come, it also may not come, and frequently does not come. It hinges pretty largely on just how intensive the cultivation of the combined plantation is. If the companion crop is such as to demand very thorough culture, then the small fruits will usually get the same and will benefit proportionately. But if the companion crop is of a type to get along with rather indifferent culture, then its interference with the cultivation of

the small fruits may more than offset any advantage. On the whole, however, the influence of the companion crop is apt to be in the direction of better culture. It certainly will be in case the same crop, if not grown among the small fruits, is to be grown on some other part of the farm, for in this latter case the competition between the two plantations for the available labor supply is pretty sure to result in a defeat for the small fruit crop.

3. A third advantage which usually comes to the small fruits from the companion crop is in the matter of fertilizers. Most companion crops are well fertilized, and some of this fertility is sure to go to the small fruits, either that year or in following years, or both.

Disadvantages.—Turning now to the disadvantages which come to the small fruits from being associated with the companion crop, we find the following list, which is likely to be more or less important:

1. A loss of the requisite amount of water. Whether this difficulty arises or not depends largely on just how thoroughly the plantation is cultivated, and on the type of soil and its humus content; but since practically all the fruits under consideration are very dependent on a liberal and continuous water supply, this objection to the companion crop ought to be very carefully considered and every precaution taken to prevent a shortage of moisture.

2. A second objection to the companion crop, which usually applies, is that it puts a stop to any cross cultivation, and this, of course, means more expense and usually at the same time less satisfactory results. Some companion crops, like sweet corn, will allow of cross cultivation; and with some of the fruits, particularly strawberries, cross cultivation may not be attempted, even though there is no inter-crop. But when cross cultivation might be used, the introduction of a companion crop which prevents it ought to be done only after carefully considering the question from both sides.

3. A third objection to the companion crop, though frequently not a very serious one during the first year of the plantation, is that it is likely to encroach on the fruit crop in the

matters of food and light and air. Some low-growing crops, the roots of which do not forage widely in the soil, may not be open to this objection; but a number of them are and ought to be thrown out for this single reason, though satisfactory in every other way. It doesn't pay to jeopardize a permanent investment for the sake of a transient one. The shortage of food will cause a poor development of the fruit plants, reducing their size and vigor; the shortage of light works in the same direction, making the plants more spindling and less likely to come into bearing quickly and to give the maximum crops when they do bear; while the shortage in air or, to speak more accurately, in air movement tends towards the development of fungous diseases in fruits with all the attendant troubles and expenses.

4. A fourth objection which ought to be kept in mind, though it is much less likely to apply to these fruits than to the tree fruits, is that the fertilizers used on the companion crop may over-stimulate the fruits and cause them to make so much growth that they either suffer injury the following winter, or go to wood at the expense of fruit in case they are not injured. Since most of the fruits under consideration will stand considerable fertility one should not over-emphasize this danger, but in those sections where winter injury is a common danger, this side of the question ought to be constantly kept in mind, for there are few more disheartening experiences than to find, when spring opens, that the fruit plantation has been damaged by the cold weather.

Intensity of Cultivation.—On the whole, the question of introducing companion crops into small-fruit plantations is likely to depend pretty largely on how intensive the cultivation is to be. If the companion crop, the owner, and the general conditions are such as to make thorough cultivation reasonably certain, then there is little danger in the venture. But if, on the other hand, any or all of these conditions are on the wrong side, then it is much better not to introduce the companion crop.

Crops to Grow.—If crops are to be used, the following will be found among the most satisfactory:

1. Beans of all kinds (with the possible exception of pole

beans), since they are apt to be profitable, require good culture and add some nitrogen to the soil, and, on the other hand, do not make so rank a growth nor draw so heavily on the soil as to damage the fruits.

2. Beets, carrots, turnips, and other similar crops are used for about the same reasons as the beans, except that they do not supply any nitrogen.

3. Potatoes are especially useful because they can be grown and handled in large quantities and their effect is usually good if one guards against too much fertility.

4. Sweet corn or the flint varieties of field corn may be used, but care should be taken to see that the rows are not run too close to the fruits. And since most of these fruits do not carry any great distance between the rows, the small amount of available space for the inter-crop may make their use inadvisable.

5. Cabbages are usually satisfactory and are frequently used. Late cabbages in particular are good because the fruit plantation can be put in thoroughly good condition and a good share of the growth of the fruit plants secured before the cabbages are set.

Many other similar crops may be used, keeping in mind the dangers already suggested.

Small fruits are, of course, often used as companion crops in orchards, and frequently currants and raspberries are used in vineyards. Usually they are profitable when so grown, and if the culture is sufficiently intensive to prevent the permanent crop from being injured the combination is good.

QUESTION

1. Define a companion crop.
2. Do you believe in using companion crops in a raspberry plantation? Why?
3. What is the most important argument in favor of companion crops?
4. What is the most important argument against them?
5. Do you think a companion crop will very often injure a permanent crop by robbing it of water? Have you ever seen such a case?
6. Have you ever used a companion crop?
7. If you have, what was it and how did it succeed?
8. What do you think is the best companion crop in your section for strawberries?

CHAPTER V

COVER CROPS

The use of a cover crop, a temporary crop to be plowed under for the benefit of the soil, is much less common in small fruit plantations than in orchards. For one thing these plantations are relatively shorter lived, and consequently the need for the cover crop is less acute, and for another thing the rows being so much closer together than with orchards make it more difficult to use a cover crop.

But even so it is very desirable that a cover crop be used whenever it is at all possible, and therefore a short discussion of such crops seems desirable in this general section.

By way of definition it may be said that a cover crop is a temporary and generally an annual crop, which is sown on the land usually towards the latter end of the growing season and later plowed under. Its principal object is to benefit the land in various ways. Usually there is no direct financial benefit from the crop, though occasionally it may be possible to sell a part of the crop and still retain enough of it to satisfactorily serve the main purposes of the cover.

Benefits of a Cover Crop.—The following are some of the principal ways in which the cover crop may be beneficial to the plantation:

1. Probably the most important benefit with the fruits under discussion is that it adds humus to the soil. The need of this has already been discussed; and no matter how thoroughly the soil may have been supplied with humus before the plantation was set out, there is certain to be a depletion of it before the plantation is abandoned. This function is better served by some covers than by others, and with very light or very heavy soils, where the humus content would be especially important, those cover crops ought to be selected that will give the largest amount of humus possible.

2. It prevents the washing of the soil. This function will

vary in importance according to the location of the plantation. On side hill lands such as are used for many of these fruits, the question of erosion is sure to be an important one. On perfectly flat or almost flat lands it would not be important, but such lands are not very often used for the small fruits except strawberries. It is surprising how slight a slope is necessary to cause damage to the soil from washing. A field which the average man would pronounce nearly level will have sufficient movement of water over its surface to cause very serious damage from washing, particularly in the early spring when the frost is coming out of the ground and the soil is wet and ready to move.

The movement of water over the surface of the soil is to be avoided not only because one loses part of the soil itself, as above suggested, but because gullies are likely to be formed which interfere with cultivation and other work in the plantation; because soluble plant food passes off dissolved in the water, and because during dry spells the water runs away so quickly that there is not time for the needed amount to soak into the soil for the use of the crop. For all these reasons the function of stopping or retarding the movement of water on the surface of the soil is a very important one, and on slopes of any degree of abruptness cover crops should be selected with fibrous root systems and recumbent tops, so that the water and soil may be held to the greatest possible extent.

3. Another valuable function which the cover crop may perform is the adding of nitrogen to the soil. This occurs, of course, only with leguminous crops such as clovers and vetches, and it amounts to very little in a poor soil where these plants will make but an indifferent growth. But if one starts with a fertile soil and uses the right crop the cover may be made a valuable feature in keeping up fertility.

4. The cover crop assists in keeping up the supply of available plant food in the soil by itself foraging among the soil particles, bringing into solution, by the action of its roots, some of the mineral materials in those particles, and building these up into its own tissues. Then when the cover crop is plowed under and decays, these materials become a part of the available store

of plant food. In this way the cover crop relieves the fruit plant of some of the rough labor, so to speak, of working over the soil particles into organic material which, even when it decays, does not go back into quite such unavailable form as it was before.

5. Closely allied to this effect is its action (provided it grows late in the autumn or early in the spring while the fruit plants are dormant) of taking up the available plant food in the soil and building it into its own tissues, thus saving what might otherwise be lost.

6. It also helps to hold snow and leaves in the plantation, thus protecting the roots and crowns of the fruits from injury, securing whatever humus might develop from the leaves, and whatever of fertilizing value might be brought down by the snow.

Altogether it will be seen that the cover crop holds great possibilities of usefulness if it is properly handled.

What to Grow as Cover Crops.—The following are a few of the most generally satisfactory crops to be used as covers in the small fruit plantation:

1. **Buckwheat.**—This is a very useful crop, performing many of the functions outlined above, but being especially strong in furnishing humus and in bringing the soil into good physical condition. And since this latter is always a difficulty with the longer-lived small fruit plantations, it is deservedly popular with growers. It does not add nitrogen and is not very strong on preventing washing of the soil. It is usually sown at about one bushel of seed per acre.

2. **Barley or Rye.**—These crops are in the same general class as buckwheat, being especially valuable from the humus standpoint. They do not have quite so good an effect on the physical condition of the soil, but are considerably better in preventing washing of the soil. In fact, with the fibrous root system, and the abundant top, which breaks down and covers the surface well, either barley or rye is effective in stopping erosion. The objection to rye is that it lives over winter and is therefore likely to be a weed the following season, growing up among the plants of the plantation and requiring some expense to kill it. For this reason many growers do not use it.

Such grain is usually sown at one and one-half bushels per acre. Of course, like buckwheat, they give no nitrogen.

3. **Clover.**—Several kinds of clover may be used, but where the weather is not too severe in winter crimson clover is probably the best, because it will make more growth before winter sets in, which is the time when most of the growth ought to be made. Sown at fifteen pounds per acre it will usually give a good account of itself, especially when it is used for several seasons in succession. It is particularly good as a cover, its fibrous roots and recumbent tops preventing almost entirely any washing of the soil. It is also one of the best crops to add nitrogen to the soil. The principal difficulty with its use with these fruits is the fact that the cultivation is usually carried pretty late into the season which does not leave time enough for the clover to make much growth before cold weather. Since it is very desirable that the fitting of the land be started early the following spring there is little chance for growth early in the season before plowing. In warm climates it may grow nearly all winter.

4. **Dwarf Rape.**—This is an excellent crop for the purpose under discussion (Fig. 16). It makes a fairly quick growth and grows late in the season so that it gives a good amount of humus; its root system, though not very extensive, is fibrous so that it holds the soil well; and the seed is so cheap that the cost is not a serious matter as it is with many other crops. It is sown at two pounds per acre which, in normal times, will cost about ten cents per pound. It does not add nitrogen, of course, but its other good points make it a desirable crop to use.

5. **Mixtures.**—Clover may be profitably mixed with any of the other three crops mentioned, but especially with rye, barley, rape, and buckwheat, and the combination will be more satisfactory than any one crop alone. In fact, the combination of barley and clover or buckwheat and clover will be found to perform admirably practically all of the functions outlined at the beginning of this chapter.

6. **Weeds.**—If the plantation is supplied with the right types of weeds (Fig. 17), that is, if they are abundant and

FIG. 16.—A crop of dwarf Essex rape as a cover in a young blackberry plantation. Rape is an excellent crop for this purpose, very reasonable in cost and efficient as a cover.

FIG. 17.—A crop of weeds in a young raspberry plantation, mostly pig-weed and rag-weed, and entirely satisfactory from almost all standpoints.

growthy without being hard to keep in check during the season of cultivating, they may very well be used in whole or in part as substitutes for the cover crops just mentioned. Such weeds as the various kinds of "pig-weeds" and many kinds of grasses (not, however, including witch grass) will perform many of the functions of a cover crop without any cost for seed or sowing. It happens that in most sections none of the plants that are likely to grow as weeds in a fruit plantation are legumes, and consequently the soil will gain no nitrogen from their growth. But for a cover, for adding humus, for bringing plant food into solution from the soil particles and for holding snow and leaves, some weeds are very effective indeed. The objection to them is pretty largely one of sentiment. We are afraid of what the neighbors will say or think! Just let the neighbors do the worrying for once and try a good crop of pig-weeds with some crimson clover added, as a nitrogen gatherer, and see if the result is not entirely satisfactory. Of course, one should be careful that serious weeds do not get a start, but if this is attended to there would appear to be really no very important way in which a crop of buckwheat is better than a good crop of pig-weeds. The block to worry about is the block that fails to grow weeds.

7. **Other Covers.**—In southern sections cowpeas are often used as a cover crop and are very satisfactory. In many sections oats are also used, but in the writer's experience are not as satisfactory as barley.

The general plan followed in the use of a cover crop in a fruit plantation is to sow the seed just previous to or following the last cultivation. This cultivation covers in the seed, or with crimson clover and some others the rain covers the seed enough when it is sown on newly cultivated soil. The crop is then allowed to make what growth it will that autumn, and is plowed under the following spring. In some fruit plantations some growth of the cover crop may be allowable in the spring before the land is plowed, but this is not usually desirable in small fruit plantations except in warm climates, and is never to be encouraged where cross cultivation is not possible.

QUESTIONS

1. What is a cover crop?
2. What do you consider is the most important single benefit from a cover crop?
3. Have you ever used cover crops or seen them used?
4. Explain the way in which a crop may add nitrogen to the soil.
5. What is the best cover crop for your section?
6. How does a cover crop affect the supply of plant food in the soil?
7. What are the good points of buckwheat as a cover crop?
8. What do you think of weeds as cover crops?

CHAPTER VI

SPRAYING MATERIALS AND APPARATUS

The problems involved in the spraying of small fruit plantations are relatively simple; first because the number of insects and diseases for which we spray is relatively small, and second because comparatively few materials are used.

Of the great number of materials on the market, or described in spraying bulletins and used for various insects and diseases which prey upon the plant world, only about a half dozen at the outside are necessary to control the pests of small fruits. These are arsenate of lead, lime-sulfur, nicotine, and perhaps arsenate of lime among insecticides; and Bordeaux mixture, lime-sulfur, and perhaps plain sulfur among fungicides. Of course, many others might be used, and some of them may have certain advantages over those mentioned for certain pests; but if one is equipped with the above list, or, in fact, with three or four out of the eight, he will never get into dangers from which he cannot extricate himself. And since it seems desirable to limit the present discussion as far as possible, only the list given above will be considered.

Of the insecticides mentioned two, arsenate of lead and arsenate of lime, are stomach poisons for the chewing type of insects, and two, lime-sulfur and nicotine, are contact poisons for sucking insects.

Arsenate of Lead.—At the present time arsenate of lead is by far the most popular and widely used poison of its type on the market, having practically driven out all such forms as London purple, Paris green, hellebore, etc. It is sold in two forms, the paste form and the dry or powdered form, with the latter gaining over the former every year in popularity. The great advantage of the powder is that one does not have the extra water to pay freight on and to add to the work of handling. As methods of manufacture have been perfected so that the powder

has been made with larger but lighter particles (flaky instead of sandy in character), so that they would not sink out so quickly in the spray cask, and would adhere better to the leaves of the plants, this form has won its way right to the front. On the other hand, there is some evidence to show that the paste stands up in suspension better in the spray tank and that as a class the pastes adhere better, so that some growers are still in favor of that form. For most work the powder is used at a rate of one and one-half pounds per fifty gallons of water, and the paste at twice that.

If the paste is used it ought to be thoroughly worked up, in additional water, before it is added to the spraying cask, and if the powder is used it should be mixed with a small amount of water (which is added somewhat gradually as the mixing progresses), and this mixture of water and powder should not be put into the cask until the mixing is thoroughly completed. Above all, do not put the powder in its original, dry condition, directly into the spray cask, as it will collect around the edges of the cask and stick there, only a part becoming mixed with the water.

Arsenate of lime, or calcium arsenate, while it has been used in a limited way for a good many years, was brought into prominence by the scarcity and high price of lead. This condition, and the patriotic duty of conserving lead for other purposes, led manufacturers of insecticides to push the sales of calcium arsenate, and its use has very largely increased. As was to be expected under these circumstances the material is not yet entirely satisfactory from the fruit-grower's standpoint. At the present time the following seems to be a fair statement of the situation. The commercial brands of calcium arsenate on the market are quite variable in composition, varying both in the total arsenic contained, so that the fruit grower is uncertain just how much should be used, and varying also in the amount of soluble arsenic contained, so that some burning of the foliage is likely to occur. These difficulties will no doubt disappear as methods of manufacture are perfected. In particular it seems to be desirable that a chemically neutral instead of an acid arsenate of

lime be developed. The latter is less stable and more easily soluble than the former.

On the other hand, it is possible to overcome to a very large extent the tendency to burn the foliage by adding an amount of lime equal in weight to the arsenate of lime used. This lime should be pure CaO, which has been previously slacked with water, so that when added it will really be in the hydroxide condition of $Ca(OH)_2$. Moreover, when calcium arsenate is used in combination with lime-sulfur there is usually no trouble from burning. And lastly, the lime or calcium is so much cheaper than lead that we get a product that costs the grower much less.

Lime-sulfur is used principally by the small fruit grower as a dormant spray on such fruits as currants and gooseberries. It is one of those substances which is at the same time an insecticide and a fungicide. Most growers use the commercial material which comes as a clear, amber-colored liquid, which mixes readily in water. Where large quantities are used it may pay to manufacture it at home, but ordinarily the best way is to buy it already prepared. The strength will vary considerably even from the same manufacturer, so that the only really satisfactory way to determine how much of it to use with a given amount of water is to test it with a hydrometer, a little instrument for measuring the density of liquids. For a dormant spray the diluted lime-sulfur should give a reading of 1.03 on the hydrometer, which means one gallon of the concentrated solution to about eight gallons of water.

Lime-sulfur in the dry or powdered form is coming into very general use as this text is being written. It has much to commend it, particularly ease of handling. On the other hand, it is, as yet, more expensive than the liquid and has some other shortcomings. These may be corrected with longer experience on the part of manufacturers.

Nicotine is by far the most satisfactory and widely used of the contact poisons for summer use. It is a tobacco product and comes in the form of a rather thick, dark brown and ill-smelling liquid, chemically the sulfate of nicotine. This mixes readily

with water and should be used at the rate of one-half pint to fifty gallons of water.

Bordeaux Mixture.—Of all the fungicides used for the fruits under discussion Bordeaux is the most popular and the most efficient, and in actual practice it is rare that any other is used as a summer spray.

The most common formula at present is 4 pounds of copper sulfate, 4 pounds of rock lime, and 50 gallons of water. Where any quantity is to be used the most satisfactory way is to prepare stock solutions, as they are called, at the beginning of the season. For this purpose a 50-gallon cask is usually used for the lime and another for the copper sulfate. The lime is prepared by weighing out 50 pounds of rock lime, slacking it, and then straining it into this cask and adding enough water to make 50 gallons.

In a similar manner the copper sulfate solution is prepared by dissolving 50 pounds of the material in 50 gallons of water. This can be done most quickly by putting the copper sulfate in a bag and suspending this in the top of the cask of water. These two stock solutions should be placed in a convenient place and kept tightly covered to prevent evaporation and to keep leaves, etc., which might clog the spray machinery, from getting in.

When it is desired to prepare a cask of Bordeaux mixture for use, stir the stock solution of lime and measure out four gallons into a cask and add enough water to make twenty-five gallons. Put four gallons of the copper sulfate solution in another cask and add twenty-one gallons of water. Then pour these two diluted solutions into the spray cask, agitate thoroughly and apply. Usually arsenate of lead is added for chewing, and sometimes nicotine for sucking insects, so that one application takes care of all three types of pests.

Bucket Pump.—Turning now to spraying apparatus, the simplest outfit that can be used with any satisfaction is the bucket pump shown in figure 18. It is entirely efficient and will do good work; is simple in construction and costs relatively little, from five to seven dollars buying a good one. But it is

inconvenient to carry about, has no agitator, so that solid materials like Bordeaux mixture are likely to settle out; and it works slowly.

Knapsack Sprayer.—Next to this in cost, efficiency and general desirability would come the knapsack sprayer shown in figure 146. This is a very efficient little machine, being especially satisfactory for rough land, or for garden conditions where one wants to get about among vegetables in doing his spraying. It is rather heavy to carry when full, works somewhat slowly, and has an unpleasant habit of slopping over and wetting the operator in the small of the back. But with care this latter objection can be avoided to a considerable extent. For a half acre or thereabouts, especially if the plantation is on a side hill, it will be found the most satisfactory machine to use.

FIG. 18.—Bucket pump. A simple but efficient little pump for small operations. Unhandy to move about.

Barrel Sprayer.—For somewhat larger plantations an ordinary barrel outfit may be used. It is possible, with a little ingenuity, to equip it with various attachments so that several rows of strawberries or two rows of grapes or currants may be sprayed at one time. Or it may be used in the ordinary way with two leads of hose as shown in figure 19.

Power Outfit.—Where an orchard power sprayer is available it may be used for any of these plantations much as has just been described for the barrel outfit. Sometimes they may be used in a vineyard even if the rows are too close together to admit of the sprayer being driven between them; the rows must be

FIG. 19.—Spraying strawberries with an orchard barrel sprayer.

FIG. 20.—Special sprayer for use in strawberry fields. It is a traction type, the power being generated by the turning of the wheels.

rather short, so long leads of small hose may be used and carried down each row.

Spraying Several Rows at a Time.—Where large plantations are to be sprayed special types of spraying apparatus are often

used. For strawberries a sprayer similar to the one shown in figure 20, which will spray several rows at once, is the most popular type. For grapes a power sprayer which is driven between two rows of the vineyard and sprays both rows at once is commonly used.

QUESTIONS

1. What spray materials are most commonly used in your section for insect control?
2. Discuss arsenate of lead.
3. Has arsenate of lime been used in your section at all? What have been the results?
4. What type of lime-sulfur is used in your section?
5. Have you seen nicotine products used for spraying in your section? For what insects were they used?
6. Describe the making of Bordeaux mixture. Would it be useful in fighting the strawberry leaf-roller? Why?
7. What sort of spraying apparatus is most commonly used in your section?
8. Have you ever seen a knapsack sprayer used? Is it a good kind of pump?

CHAPTER VII

CANNING, PRESERVING AND MARKETING

It is not the intention to introduce here an extended discussion of the question of preserving and marketing small fruits. To do that at all adequately would require a volume. The hope is merely to suggest the importance of this phase of the subject, and to discuss briefly some methods which may prove of value.

Failures in Marketing.—It is frequently said that for every man who can market a crop of fruit successfully there are a dozen who can grow one. This is probably a fair estimate. One explanation of this state of affairs is doubtless that it takes business ability to market a crop and this is just as rare (and no more rare) among farmers as among men in the dry-goods business or the hardware business. One man in the dry-goods business has the ability to conduct it successfully, and he owns the store, while the other five or ten or one hundred who have not the ability work for the man who has. If as large a proportion of those who are engaged in the dry-goods trade tried their hand at doing the marketing, as we find making the attempt to do the marketing among farmers, there would undoubtedly be as many failures in the marketing of shirt-waists as in the marketing of strawberries.

Another reason for failures in marketing fruit is undoubtedly that less time and thought have so far been expended on its special problems, and the young man who grows up on the average farm receives far less training in this line than he does in cultivation or in pruning and spraying.

A third and very important reason for the large number of failures in marketing, as compared to growing fruit, is the fact that one is dealing with a very perishable product which must be handled quickly and in which mistakes are costly and cannot usually be remedied. If the cultivating has been neglected so that the weeds have made a start, more labor can be put on the

plantation and the mistake rectified. But if the berries have been picked while wet and have developed mold, there is nothing to do but to put them on the dump and begin again.

Make a Plan.—If we accept all this as sound doctrine it would seem to indicate that the first step for the small fruit grower to take, if he expects to succeed in marketing his crop, is to sit down and try to definitely and constructively lay out a plan of campaign, beforehand! Do not wait until there are only one hundred berry boxes left before ordering a new supply; do not wait until the berries are being picked to decide where to ship them; do not wait until the glut comes to speculate on what can be done to relieve the situation.

Causes of Failure and Success.—The following are some of the things which have impressed the writer as being the cause of the success of some growers and the failure of others. Some of these points may seem unimportant; many of them may seem so obvious as to hardly be worth mentioning; but they all count and most of them count largely in deciding whether the receipts from the strawberries are so meager that they are not sufficient to pay the expenses of the plantation, or whether they are so generous that the grower can go on a vacation or buy that truck he has been wanting so long.

1. **Grow a Good Crop!**—If only we could do that, half or two-thirds of our troubles, perhaps ninety-nine per cent. of them would disappear. It is so easy to interest a customer in a box of fine strawberries or a basket of beautiful grapes. When he once becomes interested he stays so, and his interest grows. Moreover, the work of picking and packing such fruit is so much less than it is with the crop of small, unattractive strawberries, or the crop of grapes with poor, scraggy bunches. So the business grower keeps all this in mind and plans beforehand to spray and prune and cultivate in such a way that his products will make friends and not enemies of his customers.

2. **Grade the Fruit Well.**—This is somewhat less important with small fruits than with apples, for example, but it is tremendously important even here. A medium-sized strawberry, which would be perfectly satisfactory if all the rest in the box

were like it, will wreck your trade with some customers if it is put in a box along with some large berries.

3. **Pack the Fruit Well.**—Do not fill the strawberry boxes so full that the top ones are mashed in the crate; and do not have them so loose in the box that they shake to a mush in transit.

4. **Put Up the Fruit Honestly.**—There is less chance, perhaps, to pack a box of strawberries or a basket of grapes dishonestly than a barrel of apples, but it can be done, as many a disappointed and disgusted customer can testify. Get the big berries and the fine clusters of grapes (or at least some of them) into the bottom of the basket.

5. **Use Attractive Packages.**—A little extra money paid for a better grade of baskets will be more than made up by the better appearance that the fruit will make in them, and the better condition in which they will carry the fruit through a reduction in breakage. For a retail trade some really attractive baskets that are of value after the fruit has been used may be justified.

6. **Give Good Measure.**—The use of a few extra berries or an extra bunch of grapes necessary to change a scant measure to a generous one will be the best use that could possibly be made of that amount of fruit. Charge it up to the advertising account and keep up the practice.

7. **Keep the low grade fruits off the market** as far as possible. Or, if this cannot be done, place them on a different market and at least in different packages. With some markets there is undoubtedly a call for these poorer grades at lower prices, but the usual effect of putting poor and good fruit on the same market, even though they are not mixed in the same packages, is to depress the price for the good fruits. Some one has said that the reason the northwestern apple growers have been so successful in working up a good market for their fruit and in getting high prices for it, and in making people think that they grew only first-class fruit, was because they had discovered that a customer would pay more money for two good apples than he would for the same two good apples with two poor ones thrown in. Most of us insist on giving our customers these two

extra poor apples or strawberries, and whether we put them into the same package or not the effect is bad. If these grades could be worked up into some manufactured product it would be the ideal solution of the question, conserving the food supply, getting it into an excellent form for market and not discouraging our customers by giving them these poor, unattractive, disappointing specimens.

8. **Early Marketing.**—Get the fruit into the market early in the day. This applies principally to the local market, but is very important. The dealer will be interested in a crate of strawberries at 7 o'clock A.M. and will pay a good price for them, when he might not look at them at 11 o'clock. Besides, the fruit arrives in better condition in the cool of the morning than it does in the heat of the day.

9. **Go Regularly to Market.**—If your dealer knows that he can rely on your team coming in every morning or every other morning, he can plan his purchases and will buy from you regularly, while if the deliveries are irregular he will patronize some other producer.

10. **Have regular customers** among the dealers. Do not go to one store on Monday and another on Tuesday and a third one on Wednesday. If your fruit is poor this may sometimes be necessary in order not to meet your reputation, but it is fatal to the best success.

11. **Wholesale and Retail Prices.**—Do not attempt to do a wholesale and a retail business in the same town, or if this is done sell to the dealer enough lower so that he can make a fair profit and still sell at the retail price you are making. If a dealer is handling your berries and a customer comes in and asks, "What is the price of those Sea View Farm berries?" "Twenty-five cents a box." "Why, I bought some for twenty cents yesterday from their wagon!" This dealer will buy somewhere else next time.

12. **Provide for the glut** before it comes. The best way to do this is to keep the fruit off the glutted market, and the ideal plan for keeping it off is to use it in manufacturing. Can it; make jam of it! This puts it in a form in which it can be

marketed at leisure and the effect on the market of this withdrawal of fruit is to decrease, instead of to increase the glut. There is no question that this method of disposing of surplus fruits, and especially small fruits, is destined to see a remarkable development in the near future.

13. **Cater to whims** of the local market unless they are entirely unreasonable. If it prefers the Sample to the Glen Mary strawberry let it have Sample. And if it wants 24-quart crates instead of 32-quart crates, give it the 24-quart size. If it would rather have black raspberries than red ones, grow black raspberries, even though you yourself prefer the reds; and if it insists on using unripe currants for jelly because they "jell" better, pick your currants before they are ripe, even though you know that they would "jell" just as well and taste much better if they were ripe.

14. **Do some Advertising.**—Just what this shall be depends on circumstances. If one has a wide line of kinds and varieties of small fruits (as well as some other fruits) the problem is far different from that presented by a single crop, as strawberries. But even in the latter case there are many things that will help to move the crop. One of the simplest things is to put out a road-side sign. If there is to be a succession of fruits for sale this may well take the form of a regular bulletin board; but if not, a good-sized sign saying "*Strawberries*" will stop many a customer. If the spot is shady some boxes of fruit may be placed near the sign as a bait.

It is always desirable, if the fruit is superior, to let the buyer know where it comes from. Figure 21 shows how one strawberry grower, Mr. Chas. W. Mann, of Methuen, Massachusetts, does this. Over every box of berries is pasted a strip of white paper on which is printed the one word "Mann." And this has come to be a trade-mark of great value. A similar system is common in many sections of the west, notably in California. Labels on the crates accomplish a similar object, although not so well.

If the operations are on a sufficiently large scale to warrant it, a small advertisement in the newspaper is very effective and will help the grower in his dealings with the grocer or fruit-

store man, for the announcement can state that these fruits can be had at the Boston Fruit Store or the Central Grocery.

If some sort of printed matter can be introduced into the package it may be the means of making many a sale, and always has the effect of leading the consumer to realize the fact that he is dealing with a progressive grower who has ideas and *usually* grows better fruit than his neighbors. This printed matter may take various forms; it may be merely the name of the farm, or it may be a recipe for canning or making fruit butter; or it may

FIG. 21.—Display trays of strawberries used by Chas. W. Mann, of Methuen, Mass. A good method of marketing fine strawberries locally. A strip of white paper with the word "Mann" printed on it is pasted over each box.

be a more ambitious effort in the way of a leaflet. *Anything that attracts the attention of the consumer to that particular grower and his product will be worth while.*

Manufactured Products.—Reference has been made in this discussion to the manufacture of fruits into various products. Whether the grower is producing for market or merely for home use this question of canning and preserving and manufacturing is one which deserves attention. If it is merely a question of supplying the home table with fruit in some form for the entire season, the question of just what forms shall be chosen is an interesting one (particularly to the "consuming" side of the family) and ought to be studied out carefully. It is a great mis-

take to stop with merely canned strawberries and currant jelly, when one might have blackberry jam and grape butter and strawberry sunshine and grape juice and spiced currants and a dozen other things.

If the canning of fruits and making of fruit products are to be made a commercial matter, and a large part of the crop is to be put on the market in this way, then the problem is worthy of still more study, for there is more at stake. For the right type of trade there is a splendid business for anyone who will produce a good and varied line of fruit products.

Whether the fruit is put up for home consumption or for sale, it often pays to get away from the orthodox and established ways and introduce something new, or at least something less common. They may be no better than the standard articles, but they are interesting. Here are a few suggestions.

Currant Jelly.—Pick the currants over carefully, wash thoroughly and put in a kettle with just enough water to cover them. Next squeeze the currants very thoroughly with the hands or jelly press, at the same time removing the stems. Place the kettle on the stove and boil for three minutes. Pour into a jelly bag and drain. Measure the juice and boil for five minutes; then add an equal quantity by measure of hot sugar. Boil until the jelly hardens on a cold plate, pour into glasses and store as any jelly. This makes a jelly that is beautiful in color and is without any of the strong flavor which is sometimes found in currant jelly.

Canned Raspberries.—Fill clean jars with freshly picked fruit. Pour over it a boiling syrup of the density to suit the taste of the family. For most people one part sugar to two and one-half parts water, by weight or volume, is best. Seal jars and immerse in boiling water for twenty minutes, then remove and store.

Grape Juice.—Pick the grapes from the stems, wash them and put one heaping pint of the grapes and three-fourths cup of sugar into sterilized two-quart jars. Fill the jars with boiling water and seal. Turn the jars over several times until the sugar is dissolved. Store and use as wanted, straining off juice and diluting to suit the taste.

Grape Butter.—(Recipe taken from Prof. W. W. Cheno-

weth's bulletin on "The Home Manufacture of Fruit Products.") Ten pounds grapes; 1 pint water; 1 pound sugar.

Grape butter is most economically made as a by-product of grape juice. Also if made as a by-product there is less danger of crystals forming in the butter.

Stem the grapes and wash thoroughly. Cook in the water at the simmering point until the skins slip from the berries. Pour into a colander or sieve and allow the juice to drain off. This juice should be bottled and used as grape juice. Return the pulps and skins to the cooking utensil, add one-half pint of water and cook at boiling point until the berries are in rags. Again transfer to colander or seive. Rub the pulp through and return to the cooking utensil. Cook at boiling point for five or ten minutes, add the sugar and cook until of desired consistency, which should be thick enough to spread well. If spices are desired these may be added just before removing from the fire.

Have fruit jars clean and sterile, put the butter while boiling hot into these and seal at once.

If a tart butter is desired to be used as a relish omit the sugar.

The skins and seeds may be used for making a fair grade of jelly. If grapes are expensive and apples are cheap add one-third as much apple pulp as grape pulp.

Fruit as Food.—Lastly in this attempt to dispose of the fruit crop satisfactorily, all who are interested ought to join in an effort to realize themselves, and to make the consumer realize, that fruit is a food and a food of value, as well as having many other valuable characteristics. We have too long been satisfied to regard it as a luxury; something which looks good and tastes fine, but can easily be dispensed with. Our strongest argument in the past has been that fruit is healthful, that it regulates the processes of the human system. Possibly this is still the greatest reason for using it, but we certainly have a much stronger case with most consumers if we can show them that raspberries are as much a food as potatoes, and better in some ways. Too many people in times of stress are prone to take patent medicines to regulate the system and fall back on beans and potatoes as foods, when they might get both regulation and food in grapes

or raspberries. If any one doubts the real food value of fruits let him study the following table, and others like it, giving the comparative food value in calories or units of energy of different fruits, with milk and potatoes for comparison:

Composition of Fresh Fruits, Compared with Milk and Potatoes

	Water *Per cent*	Protein *Per cent*	Fat *Per cent*	Sugars and starches *Per cent*	Energy value per pound *Calories*
Milk	87.1	3.4	3.9	4.85	320
Potatoes	78.3	2.2	0.1	18.	302 as purchased. 378 edible portion.
Blackberries	86	1.3	1.0	11.	262
Currants	85	1.5	...	12.5	260
Grapes	77	1.3	1.6	19.	450
Red raspberries	86	1.0	...	12.5	250
Black raspberries	84	1.7	1.0	12.5	300
Strawberries	90	1.0	.6	7.5	177

Energy Value of Dried Fruits, Compared with Eggs and Beef

Eggs	596
Beef—hind quarter	1100
Raisins	1605
Prunes	1400
Dried apples	1350
Dried raspberries	1700

QUESTIONS

1. Have you seen some examples of good and poor methods of marketing in your section? Describe them.
2. How important is the grading of fruit? Give examples you have seen of poor grading; of good.
3. What do you consider is the best use of low-grade fruits? How have you seen them used in your section?
4. Discuss the importance of good measure in selling.
5. Compare wholesale and retail markets.
6. Describe the best retail market you ever saw.
7. How would you avoid gluts in markets?
8. Describe any advertising of fruit that you have seen done.
9. What do you consider the best product made from grapes from the point of marketing the crop?
10. Give a list of all the different ways of putting up strawberries for winter use that you have ever seen tried.
11. Did you ever consider that fruits had any great value as foods?
12. Compare small fruits with other food products as to their food value.

STRAWBERRIES

CHAPTER VIII

STRAWBERRY SOILS AND THEIR PREPARATION

Strawberries succeed well on a wide range of soils; that is, some variety or varieties may be found which will succeed on almost any type of soil except, perhaps, the very stiff clays. But more varieties will be successful, and greater success will be achieved, on some of the medium and lighter soils.

Lightness of soil tends to hasten the maturity of the plant and fruit, and is therefore especially desirable in sections where earliness is important. On the other hand, light soils suffer more from drought, which is almost sure to be felt more or less during any season, and very light soils at least are not likely to give as high quality berries.

The heavier soils are more difficult to prepare satisfactorily and to keep in good physical condition, and they, too, often suffer from drought either because they have not been well prepared and are therefore not in condition to hold moisture, or else, during the harvesting of the crop, because the trampling of the pickers has made the soil compact and hard.

The Best Soils.—On the whole, soils ranging from what would be technically classed as a sandy loam to a very light clay loam will probably best suit the strawberry grower if he can get them. In case he is in the business in a fairly large way it may pay him to select a lighter soil on which to grow his early varieties and have another bed on heavier soil for his main crop and later sorts.

Slope or exposure is not usually considered very much by the strawberry grower. The bed should always have enough slope in some direction to carry off the surface water, since standing water is fatal, and even fairly well-drained soils, if they are level, are likely to suffer in this way in winter and early spring. Beyond this requirement for drainage, slope is rarely thought of in selecting a site for the strawberry bed, yet it is a question whether it might not be profitably considered in some

cases at least. For example, where earliness is of prime importance, a considerable slope to the south may mean several days' difference in the ripening of the berries. Conversely when one wishes to get his berries on the market as late as possible, a northern slope is desirable. It is surprising how slight a slope will make a difference in the warmth of the soil and therefore in the maturity of the crop.

On the other hand, a western or southwestern slope, particularly if it is at all steep, is objectionable because it subjects

FIG. 22.—Strawberries grown by the matted-row system in a young peach orchard.

the bed to the hot afternoon sun which transpires more moisture from the leaves and evaporates more from the soil.

Preventing Damage from Frost.—In those sections where frost is likely to cause damage at blossoming time, and this includes many of the best strawberry sections, the question of elevation and slope in reference to their effect on frosts ought to be considered. Sometimes the only thing to do is to accept the danger because the advantages of the lower and flatter lands in fertility and water-holding capacity more than offset the frost danger (Fig. 22). But strawberries are so peculiarly liable to damage from frosts at the blossoming period, being flat upon the

ground and the blossoms, of course, very tender, that wherever possible the grower ought to select a site which is reasonably free from this danger.

Fertility of soil is always very desirable. Some authorities go so far as to say that it is almost impossible to get the soil too fertile for the best results, and this is probably true. It is *almost* impossible. Certainly more strawberry beds suffer from the soil not being fertile enough than from its being too fertile. The fertility ought to be of the lasting kind and ought to extend well down into the soil, that is, it is not possible to make the soil satisfactorily fertile by the application of a large amount of nitrate of soda, or other relatively quick-acting fertilizer, on the surface of the soil. What is needed is the incorporation of a generous amount of humus, and preferably humus carrying a large amount of nitrogenous materials (as, for example, barnyard manure or clover sod), and the working of this well down into the soil so that one has a surface soil from eight inches to a foot in depth which is well filled with these materials. For this reason the preparation of a soil for a strawberry bed ought to begin at least a year before it is intended to set the bed, and preferably several years before.

Rotation Principles.—Where one is permanently in the business of growing strawberries this preparation of the soil may well take the form of a definite rotation of crops such as is practiced by our best general farmers. Just what crops shall be included in this rotation will, of course, vary greatly according to the other lines of farming in which the grower is engaged. But there are two or three general principles which ought always to be considered in arranging these rotations.

1. The year previous to the setting of the bed the land ought to be planted to some hoed crop, and the more hoeing this crop requires, the more thoroughly it has to be cultivated, the better. The advantages from this are that by the clean cultivation all weeds on the block will be thoroughly subdued, and that while there will be plenty of humus left in the soil, it will not be too "raw." This latter point is vital, since if there is any great quantity of very slightly decayed vegetable matter in the soil

when the strawberries are set, such as would be the case, for example, if a grass sod or a liberal dressing of barnyard manure had just been plowed under, there is almost certain to be serious trouble with white grubs, which flourish under these conditions. Hence the need of the cultivated crop preceding the strawberry crop, and if barnyard manure is to be applied (at least, unless it is very well rotted) let it be used on this preceding crop.

2. Somewhere in the rotation, and preferably not more than two years ahead of the strawberry crop, there ought to be some sort of a hay crop, and the more clover this hay can have in it, the better. The ideal plan is to plow down the sod for the crop preceding the strawberries.

3. At least three and preferably four years ought to elapse between strawberry crops. This helps to keep down fungous and insect pests in the plantation, and insures that the soil shall get back into good shape as to fertility and physical condition, that it shall "get some strawberry back into it," as the growers say.

Good Rotations.—With these principles in mind almost anyone can get up a satisfactory rotation to suit his own conditions. The following will be found satisfactory for many conditions:

1. Plow up the old strawberry bed as soon as possible after the crop is harvested and sow buckwheat (or cowpeas in the South). If the best results to the soil are to be secured this crop ought to be allowed to remain on the land and be plowed under, but if it makes a good seed crop and the owner is anxious to do so, the crop may be harvested and the straw returned to the field to be plowed in. It is surprising, though, how insignificant the same crop of straw looks when one gets it back on the land after it has been threshed, as compared to its appearance before it is cut.

Some growers make a practice of growing late cabbages or some such cultivated crop following the turning down of the strawberry plants, that is, the same season that the last crop of berries is harvested. This gives some revenue, but usually does not result in quite as good preparation for the succeeding strawberry crops.

2. Replow the land that autumn or the following spring and plant a crop of corn. Among other fertilizers applied to this corn crop ought to be some lime. For the lighter and more typical strawberry soils the ground limestone should be used at the rate of two tons per acre, but if one has a heavy soil the burned lime (about a ton per acre) will be best. This lime is primarily to insure a good growth of clover following the corn and not that the strawberries need an alkaline soil.

3. The corn crop is followed by hay with a liberal allowance of clover in it. In many sections the grass seed is sown in the corn at the last cultivation and comes along so as to give a good crop of hay the following season. In sections where this plan has not been tried the writer would recommend its adoption, on trial at least, as it saves a whole year and usually gives most excellent results. As already suggested, this hay should be strong on the side of clover. If cattle are kept on the farm, there is, of course, no objection to this. Even where the hay is used for horses or is sold, one may well accept the objections to the hay with a large percentage of clover in it in return for the greater good to the succeeding strawberry crop. The following formula will be found good in sections where timothy does well, or orchard grass may be substituted for it:

Timothy	10 pounds
Mammoth Red Clover	8 pounds
Alsike Clover	8 pounds
Fancy re-cleaned Red Top	4 pounds

This is a fairly heavy seeding and is, of course, very strong, at least double the usual amount of clover.

One or two crops of hay may be taken off the field; that is, the field is used for hay one or two years, depending on how anxious the owner is to get the land back into strawberries. Probably somewhat better results will be secured if two years are used for hay, as this allows time for the production of a greater humus content in the soil.

4. Plow the land in the autumn (unless there is too much slope to the field) and grow a crop of beans (or soybeans) or potatoes the next year. There is not much choice between these

two crops so far as their effect on the strawberry crop is concerned, but probably the beans will give slightly better results, as they will gather some nitrogen from the air. They will also stand somewhat better an application of barnyard manure if it is desired to make one.

5. Plow the land again, preferably in the autumn after the beans or potatoes are harvested, and set to strawberries the following spring, from which one or more crops may be taken as desired.

This rotation, reduced to its shortest time, will take five years, if we allow for only one crop of strawberries and one crop of hay, or six years if we want two crops of berries. This is probably none too long for the best crops of berries, and if one has sufficient land to allow of its use, and can dispose profitably of the other crops, the plan outlined, or some slight modification of it, might well be adopted by most strawberry growers. It might be shortened a year by omitting the crop of corn, but the results would not be so good.

Where, for any reason, one cannot adopt a rotation of crops, but is anxious to get the land into the best possible condition, the plan is sometimes followed of devoting a whole season to the growing of special " cover crops " on the land and plowing these under one after another. To begin with a crop of barley may be sown in the spring as early as the soil is in good condition. When this has about headed out it may be plowed under and a crop of buckwheat sown, and if any barnyard manure is available this might be put on after the plowing and worked in with a disk harrow before the buckwheat is sown. Then when the buckwheat is in bloom it, in turn, may be plowed under and a crop of rape sown and this allowed to stand on the land over winter. The advantage of closing the season with a crop of rape is that it is not injured by frosts and therefore grows all through the autumn. Rye could be used instead, since it will all be plowed under and is not therefore open to the same objection as when used as a cover crop in the established plantation, *viz.,* that much of it is not turned down by the plow and therefore becomes a serious weed along the rows.

Of course, the list of crops here suggested does not include any leguminous crop, and if some large-growing crop of this class (say cowpeas in the South, or soybeans or field peas in the North) can be included, well and good. The objection to this comes from the fact that these latter crops do not grow as fast as the ones mentioned before, and the grower will not get as many crops (and therefore not as much humus) into his soil.

Steps in Preparing Soil.—In the actual preparation of the soil for planting out the strawberry bed the first step is to plow the land deeply. Seven or eight inches is a common depth, and some growers prefer ten inches. If possible the plowing ought to be done in the autumn. Where the land slopes so much that the soil would wash, or where for any other reason it is thought best to keep the land over winter under cover of a crop, the plowing should be done as early in the spring as the soil is in good condition to work. In any case, the plowing should be done long enough before the plants are to be set to give ample time for the capillary connection to be re-established between the furrow slice and the subsoil. If the weather is dry and the plowing is done only a short time before setting, one often fails to get that abundant supply of moisture in the top soil which is essential to the best success of the bed. Early plowing helps greatly in this respect.

After plowing, the land should be disked several times. The first time over the disk harrow should always be run the same way that the plowing was done (Fig. 3), as this turns up less of the materials that may have been plowed under. The number of times necessary to go over the piece with the disk harrow depends largely on the type of soil, but also on weather conditions and on what crop preceded the berries. It is not possible to do the soil any harm by too many diskings, and if a few days are allowed to intervene between the diskings more effective work can be done.

After the disk, various types of other harrows may be used, depending on what is available on the farm. If they can be had the spring-tooth and smoothing harrows (Fig. 4) will do excellent work. The meeker harrow, shown in figure 6, is not a

very common implement on farms, but when it can be had it is ideal to follow the smoothing harrow.

The "final touches" may be put to the field by the use of either the brush harrow (Fig. 7) or the planker (Fig. 8). Either of these can be made at home and one or both of them ought to be on every farm.

On soils which are very light and loose in their texture, the use of a roller is often recommended, and where such soils have to be used this is sound advice. But it may be doubted whether soils which require rolling ought to be set to strawberries. Certainly they cannot be expected to produce maximum crops. If a smooth drum roller is used it should be followed with a smoothing or brush harrow to reëstablish the mulch. Rough rollers or sub-surface packers may be used. These produce a mulch on the surface.

QUESTIONS

1. What effect does a light soil have on strawberries?
2. A heavy soil?
3. What are the ideal soils for strawberries?
4. Discuss the question of fertility in strawberry soils.
5. Describe a good rotation of crops which shall include strawberries as one of the crops.
6. How would you prepare for a crop of strawberries when only one year was available for the work?
7. Describe the actual preparation of the soil for a crop of strawberries the season the bed is set.

CHAPTER IX

STRAWBERRY VARIETIES AND PLANTS

I. VARIETIES

As with all fruits, the question of getting the right varieties is of crucial importance in determining the success of the strawberry bed. And as with all other fruits, it is extremely difficult to give accurate and specific advice on the choice of varieties. But we have this additional difficulty with strawberries, that with no other fruit do we find the behavior of a certain variety varying so much in a short distance or limited area. A variety may do well on one farm and be almost an absolute failure on another farm only a few miles away. Of course, we find some varieties, as the Sample, Klondyke, and Senator Dunlap, that are fairly generally successful, much more so than some other sorts as the Marshall; but we have only a few varieties that succeed well over such a wide area as the Ben Davis or Oldenburg apple, or the Elberta peach or the Snyder blackberry.

For this reason specific varieties will be left out of consideration for the most part in the present discussion and consideration given to the general characteristics of varieties.

Variety Characteristics.—The following are some of the characteristics which ought to be considered in choosing varieties for setting:

1. **Kind or Sex of Blossoms.**—This is an all-important point. With many varieties the blossoms contain all the different parts of a complete flower, *i.e.,* the green calyx on the outside; next the white petals of the corolla; next the stamens which are each made up of a little stalk called the filament, with an enlargement in its end called the anther; and lastly the pistils in the center of the blossom. In this case there are a large number of pistils, one for each seed which develops on the surface of the ripened strawberry. It is the province of the stamens to produce the pollen grains, which are contained in the anther and which

pollinate the pistils. Blossoms of this type are said to be perfect, or bisexual.

With many other varieties the stamens are either wanting altogether, or are rudimentary and produce no pollen of any value. Blossoms of this type are called imperfect or pistillate (Fig. 23). In varieties with these last two types of blossoms, no fruit, or very little, will be produced unless other varieties having pollen-bearing blossoms are planted with them. Just what proportion of the perfect-flowered sorts will be required to fertilize imperfect sorts will depend somewhat on the abundance of pollen produced and also on the length of the blooming period

FIG. 23.—Types of strawberry blossoms. Staminate or perfect at left, pistillate or imperfect at right, and intermediate type, with poor stamens, in the center.

of the imperfect sort. Usually one row of the perfect-flowered variety to three of the imperfect will give an abundance of fruit. Where the imperfect sort has a very long season of blossoming it may be wise to plant two pollenizers with it, one to pollinate the first half of the blossoms and the other to pollinate the last half. In this case probably the best plan of setting will be one row of the early pollenizer, two rows of the imperfect variety, one row of the late pollenizer, two rows of the imperfect variety, and so on.

2. **The Season of Ripening.**—In most sections the local market will give the best prices for very early berries, and the next best for very late ones; while the intermediate ones command less money. Other things being equal, therefore, the grower who caters to his local market should get the most money out of his early and late varieties. But of course "other things" are frequently *not* equal and the productiveness or other

good quality or a mid-season berry may make it the most profitable of all. Season of ripening, however, is always of importance and ought to be carefully considered.

3. **Productiveness.**—The importance of this needs no emphasis, for it is berries that we are after and lots of them, and the shy-bearing variety has no place in any plantation, least of all in the commercial one. A point on productiveness that *does* need emphasis, however, is that a variety may be very productive with one grower and under one set of conditions, and very unproductive with a fairly near neighbor, so that local evidence as to its behavior is very desirable; and the more local the evidence can be, the better.

4. **Size of Fruit.**—In spite of the fact that medium-sized strawberries, like medium-sized fruits of any kind, are usually very much better than overgrown ones, the large berries are the ones that sell, and many varieties are popular and profitable principally because of their large size. It is certainly true that small-sized varieties are to be avoided, and with the present enlightenment of the consuming public, the larger the berry the better. A variety of which a dozen berries would fill a quart box would need little else to commend it.

5. **Quality.**—In spite of what has just been said about size, the factor of quality is important. It probably is not as important with strawberries as with such a fruit as the apple, which is eaten out of hand and largely without any "amendments," for with strawberries the flavor, or lack of flavor, is pretty well concealed by the cream and sugar that we eat on them. But still quality does count, and one reason for the popularity of the Marshall, for example, is no doubt its high quality.

6. **Color.**—This is not of great importance, and still it is worth considering, for a handsome, bright red is more attractive than a dull, washed-out shade.

7. **Firmness of Flesh.**—This is, of course, much more important in a berry to be shipped long distances than in one which is to be handled on the local market, but in any case is a valuable characteristic if it can be had without sacrificing other and more important points. For a long-distance shipper it is

frequently regarded as the crucial point in a berry, and varieties are sometimes grown which have little else to commend them than fine color and firmness of flesh. This partly accounts for those disappointing experiences one has in the winter and early spring when he buys a box of those handsome out-of-town strawberries expecting a treat, but gets a shock instead. This is further emphasized if the berries have been shipped a great distance.

8. **Plant Making.**—Varieties vary greatly in their ability or tendency to send out runners and make new plants. The practical importance of knowing this character of a variety is so that one may set the plants close enough together to insure a full stand and yet not so close as to give too much overcrowding. As a matter of fact, most varieties tend to set so many plants that the rows are too crowded for the best growth of the plants. On the other hand, a few varieties set plants so sparingly that the original plants must be set close together to insure a full stand in the row when it comes to the fruiting stage.

9. **Resistance to Disease.**—The one serious strawberry disease for a large part of the country is the leaf spot, and varieties vary greatly in their ability to withstand its attacks.

10. **Vigor of Plant.**—This is another point on which there is a marked difference in varieties, so much so that it is sometimes even desirable to vary the fertilizing of the plants. In any case, it is desirable to know how a certain variety stands in this matter.

11. **Length of season of ripening** is a point worth considering, though it is rarely mentioned in discussions. Some varieties can be harvested in two or three pickings because the blossoms all open at nearly the same time and the berries are therefore all nearly of the same age (Fig. 24). Other varieties extend over a long period of time, the oldest berries being ripe when the youngest are just set (Fig. 25). With the home plantation this latter characteristic is to be desired, while with commercial beds it may not be.

12. **Popularity.**—A last point which it is worth noting in regard to a variety is its popularity. While consumers know

strawberry varieties much less than they do apples, for example, yet a well-known and popular sort, as Marshall, has a distinct advantage over some new sorts as Baltimore and Bull Moose.

General Considerations.—In addition to keeping in mind the foregoing varietal characteristics, the following general observations are worthy of attention in deciding upon varieties.

1. **The Use to be Made of the Fruit.**—The choice of a variety is going to vary greatly, depending on whether it is to be used on the home table or sent to market. If the former, then

FIG. 24.—Cluster of fruit from a short-season variety of strawberry. Note that most of the berries are fully ripe and the youngest one has reached the white stage. Compare with figure 25.

FIG. 25.—Cluster of fruit from a long-season variety of strawberry. Note that while the oldest berry is ripe, the youngest is just set. Compare with figure 24.

quality is the all-important thing, for we can rely on the family taking what is given them provided the flavor is good; while the buyer (unless he is a very exceptional buyer) is going to be influenced far more by the color and size and general attractiveness of the fruit than he is by its quality, which he usually does not know anything about until he gets home. Doubtless one can overcome this somewhat in a really personal market, where the buyer comes into rather intimate personal contact with the grower, and is influenced by what the latter says of the quality of his berries; but it is such a universal characteristic to be

attracted to a handsome fruit that it is uphill business trying to push the unattractive sorts.

2. **An Experimental Plot.**—By all means the most useful and satisfactory way of settling the variety question is by trying out the varieties on the home place. This gives first-hand, personal information that cannot be equaled in any other way. Fortunately, too, it is not an expensive operation. Strawberries are so short-lived and so inexpensive, and moreover occupy so little room, that almost anyone can afford to run his trial bed. Certainly an experimental plot ought to be a part of every commercial strawberry plantation, for even after one has selected a set of reasonably satisfactory varieties, there is such a continual procession of new and promising varieties that there is constant danger of missing something especially good if one neglects this work. Of course, it is not good policy to try everything that comes along, but after the experiment stations have tried them and sifted out those which give reasonable promise, then the grower should step in and bring the test to a final personal finish. Besides the new varieties, there are constantly cropping up old ones that have never been tried out on the place but which have proved successful in some other place, and the behavior of which on the home farm ought therefore to be observed.

In addition to the practical commercial value of this plan there is the added advantage of its interest which ought not to be overlooked. Most successful fruit growers become enthusiasts in their line and want to test out everything in sight in the way of varieties. Many an apple grower has been seriously crippled by yielding to this temptation and getting forty varieties instead of four into his orchard. But with strawberries there is a chance, for the reasons set forth above, to combine business and pleasure by letting one's enthusiasm for new sorts of the fruit have full play.

3. **Advice from Neighbors.**—Next to personal experience, one gets the very best advice on the variety question from his neighbors, and the nearer they are, of course, the better. A neighbor just over the fence with the same or very similar soil,

and with a good-sized strawberry patch and a disposition to impart his knowledge, is a boon to any intending strawberry grower, and if necessary can pretty nearly obviate the necessity of the experimental plot, though the owner thereby loses all the fun of watching over his new candidates and debating with himself whether or not they ought to be elected to a place on the home team.

4. **Demands of the Market.**—A fourth general principle which is worthy of some consideration, though it is by no means as forceful an argument with strawberries as with apples, is the

FIG. 26.—Types of strawberry varieties.

demand of the particular market for which the crop is grown. Some markets prefer the Marshall to any other variety; others want the Dunlap, and still others the Sample! And while these markets will take other sorts, it is much easier to sell them what they want, and the grower ought to select these varieties if it is at all possible for him to grow them profitably (Fig. 26).

5. **Adaptation to Soil.**—Lastly, one ought to specifically and constantly and carefully consider his own particular soil, and just as far as it is possible to find out the soil preferences of varieties, he ought to choose those sorts that like his type of soil. This is, of course, one of the strong arguments in favor of the home experimental plot—that one secures indisputable information on this variety question.

II. STRAWBERRY PLANT

Propagation.—The strawberry is propagated principally by means of runners. These are long, slender, cord-like stems which are sent out by the mother plants and at their nodes or joints produce a cluster of leaves and later send down roots forming a new plant. Each cord may produce from one to three or four plants. With good soil conditions the runners take root readily and need no assistance; but if for any reason one is anxious to have them root in the shortest possible time and to get the largest possible number of plants, some assistance may be given. This may be done either by placing a clod of earth or a small stone just back of the joint to hold the runner in place while it roots; or if the leaves have started fairly well at the node it may have some soil heaped up about it to hasten the rooting process. The runner method of propagation gives plants that are true to name, that is, a runner-plant grown from a mother plant of the Glen Mary variety will be a Glen Mary plant.

Where new varieties are desired, the seeds from the berries are used, and, as with most other fruits, the seedling plants will vary widely from the parent. This method is very rarely used, of course; never in the ordinary commercial business of propagating strawberries for fruit. If it is used it is practiced by the experiment stations, by commercial propagators of strawberries, and by amateur enthusiasts.

Plants With Good Roots.—With runner plants there is, at the time of taking up the plants for a new bed, naturally a wide variation in the size of the first and last plants set on any particular runner cord. The first one may be as large as, or even larger than, the original mother plant, with abundant roots and leaves, while the last one set has small, rather weak roots and few and small leaves. Most growers prefer not to use these small, weak plants last formed, and a few object to the very large ones. As a general rule, it is safest and probably best, where one has a choice, to select the medium-sized plants; and large, vigorous roots with small leaves are always to be preferred to the reverse—small roots and large leaves (Fig. 27).

But whatever the size of them, the plants should be vigorous, with good and reasonably abundant roots (Fig. 28). This means that it is not good practice to take them from old beds where they have been weakened by crowding and disease. In-

FIG. 27.—A poor type of strawberry plant; leaves too numerous and too large, roots too small. It has been allowed to grow too much in the spring before taking up.

stead they should come from new plantations, and if possible from mother plants which have not yet fruited.

A Propagation Bed.—Some growers make a practice, and it ought to be more common, of setting aside a particular bed, or part of the bed, for propagation purposes, instead of taking the

plants promiscuously from the fruiting rows as is usually done. If this custom is followed, the entire row, or section of the row, is dug out when planting time comes, the most satisfactory plants are selected for use, and the balance are thrown away. This has the double advantage of not damaging the fruiting bed, and of allowing one to cull out the plants and get the very best for setting.

Digging Plants.—Where one digs his own plants the work should be done with a spade, a trowel or a spading fork, depend-

FIG. 28.—A good type of strawberry plant, small, compact leaves and abundant compact root system.

ing on whether the entire row is to be dug up, or the plants taken out here and there; also on whether the roots are to be shaken free from soil, or the plants moved with a block of earth about them, as shown in figure 29. If the entire row is to come out, then the larger implements will do the work more quickly, either one being used where the roots are to be shaken out (though the fork is perhaps to be preferred). The spade may be used if soil is to be moved with the plants. In case the plants are taken here and there from the fruiting row, a trowel or other small implement is necessary in order to disturb as little as possible the remaining plants. In any case it ought to be remembered that the later in the spring the plants are dug, the poorer

they themselves are and the more the bed is injured by the digging process.

Plants for August Setting.—Where it is desired to move plants in August or September or later, with the idea of getting some fruit the next year, use the strongest field plants; or potted plants are often used; the potted plants may be used by growers wanting only a few plants. Small pots, two and one-half to

FIG. 29.—A strawberry plant taken up with soil about the roots. If rightly handled such a plant can be moved without checking its growth.

three inches across, are sunk in the soil with the top just at the surface. If the runners have started to root, they are set in the pot as any other plant would be. If they have not yet sent out roots the little plant is placed on the surface of the soil in the pot and is held there by a small stone or clod of earth (Fig. 30).

When plants are to be purchased they should be bought from a dealer as near home as possible, since there is great danger of their heating in the packages if sent from a distance. As with any other stock, the order ought to be placed just as early as possible so as to be sure to secure the desired varieties. Prices, of course, will vary greatly; but from 20 cents to 50

cents per dozen, 75 cents to one dollar per hundred, and $3.50 to $8 per thousand is about right. It will require 9680 plants to set an acre of bed with the rows three feet apart and the plants 18 inches apart in the row. If the rows are put at four feet the number of plants required will be reduced to 7260.

Pedigreed Plants.—Some dealers advertise what are called pedigreed plants; that is, plants grown from selected and espe-

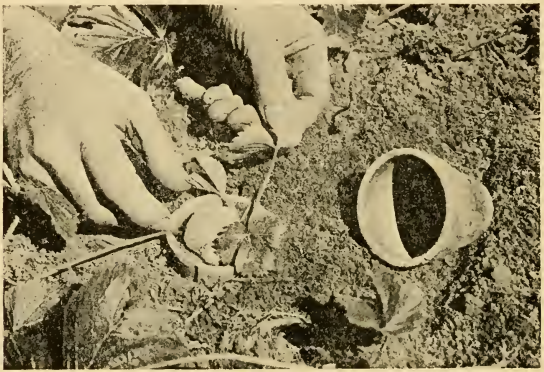

FIG. 30.—Potting strawberry plants. Small pots are sunk in the soil, the runner is placed on top of the pot and held in place by a small stone or clod of earth, then the soil is pulled up over the edges of the pot.

cially strong and prolific mother plants. While this is sound in theory, it is doubtful whether, with the present knowledge of the subject, the planter is justified in paying any extra for such plants.

Care of New Plants.—When plants brought from a distance arrive, they should be very carefully heeled in unless they are to be set at once. This must be done with the greatest care, otherwise they deteriorate very rapidly. They should be placed in a mellow and moist soil, in a spot where they will be sheltered from sun and wind. Each package should be opened and spread out enough so that the roots of every plant will come in contact with the soil, which should be pressed very firmly about

them. After they are in place a thorough watering will be a great assistance in keeping them fresh and vigorous. Great care should also be exercised to see that the soil does not cover the crowns if they are to remain here for more than a day or two. Lastly, it is very important to see that the different varieties are kept separate. A little space should be left between the different lots and a large label stake driven down with each variety, otherwise one has no notion where Sample ends and Senator Dunlap begins.

QUESTIONS

1. Can you tell the difference between staminate and pistillate varieties of strawberries when they are in bloom? What is the difference?
2. How important is the season of ripening of a variety of strawberry?
3. Is size of fruit important in strawberries? How important?
4. How much attention ought we to pay to quality in a strawberry?
5. How would you vary your choice of varieties depending on the use to be made of them?
6. How important a factor is soil in deciding what varieties of strawberries to set?
7. How are strawberries propagated? If you plant the seed of a Marshall strawberry, what kind of fruit will the seedling plant that you grow bear?
8. What is a "propagating bed?"
9. What is the proper way to dig and handle strawberry plants?
10. Would you buy pedigreed plants? Why?

CHAPTER X

SETTING THE STRAWBERRY BED

One of the first questions to decide in establishing a strawberry bed is what system shall be used in laying it off. There are four fairly well-recognized systems in use, with many modifications of each of them.

The Hill System.—To begin with, we have the hill system. The chief difference between this system and all others is that no runners are allowed to set; as fast as they develop they are pulled or cut off, so that all the vigor of the plant goes into producing a heavy crown the first season, which in turn means large and abundant fruit the following season (Fig. 31).

Hill System in Beds.—If the labor of cultivating is to be done entirely by hand, as is frequently the case with the hill system, the plants are set in beds of four or five rows, with a pathway about eighteen inches wide between the beds. The plants in the beds are set equally distant apart in both directions, the distance varying from twelve to twenty inches, with perhaps fifteen inches as the most common distance. With this arrangement the common hoe and the wheel hoe are the principal implements used, and the labor cost is, of course, high.

Hill System in Rows.—Where one wishes to use horse labor for cultivating between the rows they may be placed from twenty-five to thirty inches apart, and the plants usually twelve to eighteen inches apart in the rows. Each plant is treated exactly as in the "bed" method; that is, all runners are removed and all the strength of the plant is thrown into the production of a heavy crown.

Which Hill System to Use.—The question as to which of the above methods to adopt (the bed or the row) in using the hill system, depends largely on the available supply of labor and land. If labor is scarce, as it frequently is, then more berries can be raised per hundred dollars of labor by introducing horse

labor for the work between the rows. On the other hand, if land is scarce, and high in value, so that the rental item is important, then the bed method may be best, as one can raise more berries per acre by this method.

The Hedge-row System.—Next to the hill system we have the two hedge systems, the single hedge and the double hedge.

FIG. 31.—Single crown in the hill system of growing strawberries. Such a plant will produce a large number of the finest berries.

In the former the plants are set about two feet apart in the row and two runners are taken out, one in each direction in the row, and allowed to root about eight inches from the mother plants. All other runners are removed. At the end of the season we have a single row containing three times as many plants as were set. Compared with the hill system, therefore, there is a great saving in the cost of plants, which is one of the big items of expense in the latter, where the plants are bought. The rows in the single hedge system are from two to three feet apart, though

seldom as far as three feet. All that is necessary is to allow ample room for the plants to form large crowns and still have plenty of space to get through with the cultivator. Thirty inches will usually be ample even for the largest growing varieties.

In the double hedge-row system each of the mother plants is allowed to set four runners which are placed so as to form two new rows a little outside of the original row (Fig. 32). In

FIG. 32.—Upper line, strawberry plants set on single-hedge system; lower line, double-hedge system.

either the single or double hedge systems some growers allow each of the original runners to set one additional runner, thus increasing the number of plants in the row. The rows in the double hedge system are placed a little farther apart than in the single hedge to allow for the somewhat wider row.

The advantages of the hedge-row systems (Fig. 33) are, first, that the runner plants being spaced and the number of them reduced, there is no crowding, and each plant has ample room to develop a large crown, which, of course, means large and abundant berries. Second, the number of plants required

is very much less than in the hill system, so that the cost of the bed is greatly lessened where one has to buy the plants.

The disadvantages are that it requires a great deal of time to set the runners which are to be retained and to remove the superfluous ones, and also that one must keep the bed constantly in mind to be sure that none of this work is neglected. This latter point is more serious than many might realize. The amount of labor is not such a serious matter if one can get it

FIG. 33.—Hedge-row system of growing strawberries. An excellent system for growing fine berries.

finished up and out of the way. But, particularly where one is engaging in other branches of farming, as is usually the case, it is a somewhat burdensome matter to have to keep constantly in mind that the runners in the strawberry bed must be watched and either set or removed.

The Matted-Row System.—The last type of system is the matted row. In this the plants are set from fifteen to thirty inches apart in the row, depending on the ability of the variety to set runners. Some varieties, as the Dunlap or the Klondyke, send out numerous runners with long cords between the nodes and may therefore be set thirty inches apart and still insure that there will be plenty of plants set, while others, as the Marshall or

the Glen Mary, set fewer runners on shorter cords and must therefore be set closer together.

There are two types of this system, the wide and narrow (Fig. 34) matted row, depending on the width of the space in which the runners are allowed to set. Of course, there are all sorts of variations in widths, but typically the narrow matted row is about a foot wide and the wide row about two feet. To allow for this difference the rows are spaced farther apart in the latter, usually three feet in the narrow and four feet in the wide row.

Distances for Planting and Numbers of Plants.—The following tables give some of the usual distances apart for rows and plants in the rows, and the number of plants required to set an acre:

Distances Between Plants and Rows

System	Distance between Plants *Inches*	Distance between Rows *Inches*
Hill	12 to 20	24 to 30 if in rows.
Single hedge	24	24 to 36
Double hedge	24	30 to 36
Narrow matted row	15 to 30	36 to 42.
Wide matted row	15 to 30	42 to 48.

Number of Plants Per Acre

Distance between plants *Inches*	Distance between rows *Inches*	Number of plants	Distance between plants *Inches*	Distance between rows *Inches*	Number of plants
12	12	43,560	24	30	8,712
12	24	21,780	24	36	7,260
12	30	17,424	24	42	6,223
15	15	27,878	24	48	5,445
15	30	13,939	30	36	5,808
18	18	19,360	30	48	4,356
24	24	10,890			

It will be seen from the above table that if one sets an acre of strawberries in the hill system at 15 inches each way it will require 27,878 plants, while an acre in the matted row system at 24 by 42 inches, which would be average distances, would

require only 6223 plants. At five dollars per thousand, which is a fair average price, this would mean thirty-one dollars and eleven cents for plants for the matted row acre, and one hundred and thirty-nine dollars and thirty-nine cents for the acre in hills. Of course, this estimate does not allow for any walks which might be left between the hill beds, and which would reduce somewhat the number of plants required; but even at that, it

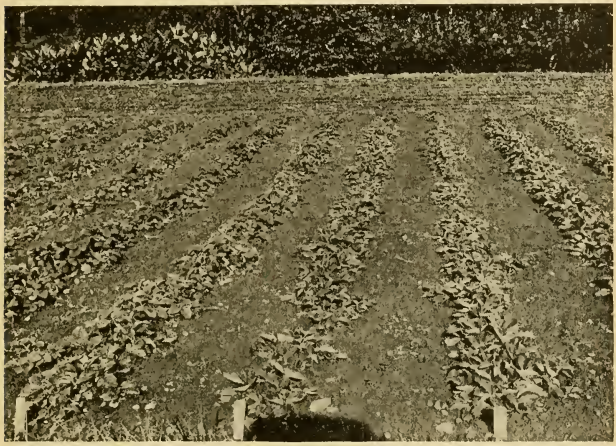

FIG. 34.—Strawberries grown by the narrow matted-row system. This is probably the most generally satisfactory system, being easy to handle and giving a large quantity of fine berries.

will be seen that the relative cost for plants is very much higher in the hill system.

Marking Off.—Having decided on the method to be used in planting the bed, the next question is to mark it off. For this purpose various kinds of markers are in use, but for the most part two types are used, either the sled type (Fig. 35) or the rake type (Figs. 36, 37 and 38). The former is modeled after the old style corn marker and consists of a number of sled runners with a light frame to hold them together and a light tongue or pair of shafts with which to drag the marker over the

FIG. 35.—Sled-runner type of marker. An excellent one where soil conditions are good.

FIG. 36.—Starting to mark off a berry patch with a rigid, three-row marker. Notice the holes in the "backbone" to allow for adjusting the teeth to different distances.

field. The runners are spaced the distance apart that it is desired to have the rows.

The rake type is like an immense wooden rake, the backbone

FIG. 37.—A marker with a hinge in the "backbone" to allow for inequalities in the surface of the soil. An improvement over the rigid marker shown in figure 36.

FIG. 38.—Same marker as figure 37 in operation. Notice the bend in the "backbone."

of which is a piece of scantling, say, two by three inches, and six or eight feet long. Inch holes are bored in this, three or four inches apart, for its entire length and a number of teeth are made for it. These teeth are about a foot long and are made

from two-by-three-inch material and sharpened at both ends. One end is made to fit into the inch hole and the other is sharpened so as to make a mark as the marker is dragged across the field. The great advantage of this marker is that by means of the movable teeth it is possible to space the rows at any desired distance which is a multiple of three or of four inches. It also makes a plain mark in almost any soil.

The first row across the field may be established by a line of stakes or, in smaller blocks of land, by a cord stretched across the field (Fig. 39). In either case the man who pulls the marker follows the line thus established and marks off three or four rows, depending on the number of runners or teeth on his marker. On the return trip he allows the first tooth of his marker to travel in the last mark made on the previous trip and goes back and forth thus until the whole field is marked off. These marks establish the rows. A wheel marker is shown in figure 40.

Places for Plants in the Rows.—It next becomes necessary to establish the points in the rows where the plants are to be set. With the matted rows and even with the hedge systems, it is often considered sufficiently accurate to allow the men setting the plants to do the spacing, since in these systems absolute accuracy is not essential unless one expects to cultivate in both directions. The men are simply told to set the plants every fifteen or eighteen or twenty-four inches in the row and are left to use their judgment in the matter. Since different growers vary greatly in the distances at which they set their plants it stands to reason that the above plan is likely to be quite accurate enough except where cross-cultivation is to be practiced.

In the hill system, on the other hand, where greater accuracy is desired, or in any of the systems where cross-cultivation is to be practiced, it becomes necessary to mark the field in the opposite direction. For this purpose a lighter-weight marker of the rake type is best for the hill system, the operator cross-marking one bed of four or five rows at a time, lifting up the rake bodily, after drawing it across the bed, and throwing it back across the bed as one would in operating a common rake.

In case one wishes to cross-cultivate the matted row or hedge

FIG. 39.—Pressing the line into the soil to mark the first row. If this is not done the line may be pushed to one side as the marker is pulled along it and the row will not be straight.

FIG. 40.—Wheel type of marker. Excellent in soft soil. Not good on stony or heavy clay soils.

systems (which, of course, can be done only during the early part of the season before the runners begin to root), the cross rows are marked with one of the other types of markers which were used the long way of the bed.

Making the Holes for Plants.—The marking being now accomplished the next question is how the holes for the plants

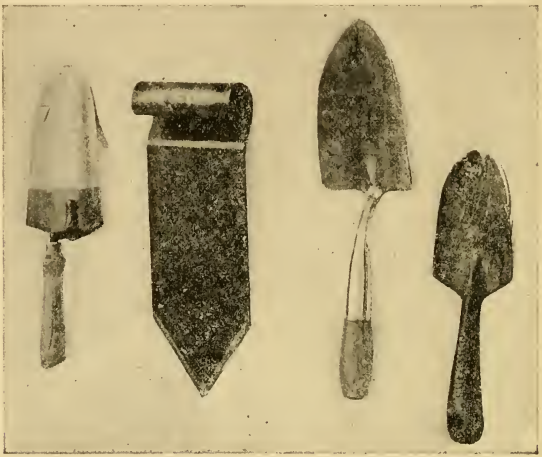

FIG. 41.—Types of trowels used in setting strawberry plants. The one at the extreme right is one of the best types.

shall be made. There are all sorts of methods in use, but the following are the most common:

1. Where the soil conditions are good, a mellow soil, well prepared and with few or no stones and gravel in it, the men who set the plants can make the holes with their hands. This is by all means the best method if it can be used satisfactorily.

2. Where soil conditions are not quite so good some sort of trowel or dibble may be used (Fig. 41). The important points for such an instrument are that it be of good size so as to open a large hole for the plant and that it have an ample and com-

fortable grip for the hand, otherwise the work will be slow and a good many blisters will be likely to be produced.

3. Another plan sometimes used under similar soil conditions as the last is to use a spade, one man pushing down the

FIG. 42.—Spade method of setting strawberry plants. Inserting the spade.

FIG. 43.—Inserting the plant behind the spade.

FIG. 44.—Spade inserted the second time to press the soil against the roots of the plant.

FIG. 45.—Pressing the soil against the plant.

spade and shoving it forward while a second man inserts the plant behind the spade (Figs. 42 to 45). This is pretty sure to prove a slow method per man employed with average men, though some remarkably good records have been made with it where the men really "hustled."

4. Sometimes an ordinary hoe is used to make the holes, this being made a special operation by a man who goes ahead of those setting the plants and digs a hole at the proper place.

Setting Teams.—With any method other than the spade method of making the holes, it will be found most expeditious to use gangs of three men, or two men and a boy, for setting. The boy or one of the men goes ahead with the plants in a pail containing a little water to keep the roots moist, and drops them at about the right points for setting (Fig. 46). This leaves the setters nothing to do but to "set," and with anything like a good team the work goes forward very rapidly.

The setting of the plant is somewhat difficult to accomplish satisfactorily. There are four essentials to good setting.

1. The plant must be set at just the right depth, neither too high nor too low (Fig. 48). Since the strawberry plant has a definite crown or growing point, if it is set too deep this bud becomes covered over with soil and the plant is likely to die. On the other hand, if the plant is set too high the upper ends of the roots are exposed and the plant dries out and usually dies. It should be set with the central bud or growing point just nicely above the surface of the soil.

2. The roots of the plants should be spread out well. One usually has to be satisfied with getting the roots spread into a fan shape, but even this requires careful attention if it is to be well done. Here again the ample number of roots on the strawberry plant makes it a little more difficult than with some other plants to see that the roots are not doubled up and wadded into the holes.

3. The soil must be pressed firmly about the roots. This is no more important than with any other kind of plant, but is perhaps a little more difficult to accomplish, since the strawberry plant has rather a bushy root system. It will usually be found necessary to keep constantly after the setters to see that this firming of the soil is properly done. A good test to apply is to take hold of the top of the plant and pull gently, and if it has not been set firmly enough it will pull out very readily, and the one who set it can be cautioned to put in more pressure.

FIG. 46.—Setting strawberry plants. One man to drop the plants and two men to set. Roots of plants left wet.

FIG. 47.—The planting machine is sometimes used in setting strawberry plants. The plants are set, watered and fertilized in the one operation.

4. Leave the soil loose on top. This means that after the soil has been pressed about the plant to make it firm, just a little loose soil shall be placed on the surface to prevent evaporation. It is very easily done, but is very helpful in keeping the soil about the plant in good condition.

In the actual operation of setting the plant the hand, or

trowel, is thrust into the soil to a depth of three or four inches and the soil drawn towards the operator, with the other hand the plant is then slipped into the hole thus opened, spreading the roots as much as possible, but holding the crown of the plant just a little higher than it is expected to be when set. The soil is then allowed to fall back against the plant and at the same time the crown is lowered a little, which spreads the roots still more. Then both hands are used to press the soil firmly about the roots; and lastly, with the fingers spread out to make a sort of rake, the hands are drawn past the plant, one on either side

FIG. 48.—Strawberry plants set at various depths; left hand plant set too deep; middle one too shallow; right hand just right.

of it, to leave the surface soil loose. Of course, every setter acquires his own little variations as one does in any operation.

The Spade Method.—Many growers use a spade in setting their beds and usually have two men, or a man and a boy, work together. The man handles the spade and the boy the plants. The spade is thrust down at an angle of about 45 degrees and to a depth of about six or eight inches. The handle is then pushed forward and the plant slipped down by the boy into the hole thus opened up, being careful to spread the roots out as much as possible. The spade is then withdrawn and the earth firmed down about the roots either by inserting the spade into the earth a few inches in front of the plant and pressing it backward, or by the man stepping just in front of the plant as he

goes forward to set in his spade for the next plant, or by both methods.

Planting Machines.—Some growers who operate in a large way use planting machines such as the one shown in figure 47. These machines are designed and used more for vegetable and tobacco setting, and the roots of the strawberry plant cannot be spread out quite as satisfactorily as in some of the hand methods, nor can they be set quite so accurately as to depth, but surprisingly good results are sometimes secured by it.

Plants with Soil About the Roots.—With potted plants or with the method discussed in the preceding chapter of taking some earth with the plants (either in a transplanter or merely as a "sod") the holes for the reception of the plants are opened by hand where the soil is in good condition, or with a hoe or trowel if it is more compact, or with a special implement in the case of the transplanter. The principal thing to guard against in all these methods is leaving a hole underneath the plant. If the soil is in first-class condition, mellow and moist, there is likely to be little difficulty; but with unfavorable soil conditions and without constant vigilance, it is sure to happen, and one loses all the hoped-for advantage of not giving his plants any set-back.

QUESTIONS

1. Describe the hill system of growing strawberries. Did you ever see a bed set in this system?
2. Describe the hedge-row system of setting strawberries.
3. Do you think this is a good system? Why?
4. Describe the matted-row system of setting strawberries.
5. Which of these systems would you use and why?
6. Describe the marking off of a strawberry bed.
7. How would you make the holes for the plants?
8. Describe the setting of strawberry plants.
9. Have you ever seen a planting machine used to set strawberries?
10. Describe the method of setting strawberries with some soil about their roots.

CHAPTER XI

CULTIVATING AND FERTILIZING STRAWBERRIES

Thorough cultivation of the strawberry bed is absolutely essential to success. In most cases this cultivation ought to begin just as soon as the bed is set and continue well into the autumn; in fact, just as long as the plants are growing.

There are three principal objects to be secured by this cultivation. The first is to keep down the weeds, which is, of course, the first thing (and often the only one) that most people think of in connection with cultivation. It is particularly important with strawberries, since they are rather shallow-rooted; and the loss of moisture through the weeds, as well as their competition for air and sunshine, is a serious handicap. And the more crops it is expected to take from the bed before it is abandoned the more important it becomes to start it off with as few weeds as possible.

The second object of cultivating the strawberry bed is to conserve soil moisture, and this is exceptionally important with this crop. Hardly a season passes in most sections when the crop is not cut short more or less through lack of soil moisture, and the amount lost by evaporation from the surface of the soil (as well as that pumped out by weeds) is tremendous.

Lastly, a great deal of plant food is liberated through cultivation, and this is very important with strawberries since their roots do not forage widely and must therefore be supplied with an abundance of fertility in the relatively small amount of soil from which they draw their food.

The best implements for tillage will vary somewhat with localities, soil conditions, and systems of setting, but the following are the most important types.

Wherever possible the cultivation should be done by horse labor, since this greatly reduces the expense. On very large plantations the two-horse cultivators are used, but for the most part some type of one-horse cultivator is best. A cultivator with

fairly large teeth (usually five or seven) will be found most satisfactory (Fig. 9) on heavy soils, which are always more difficult to work up satisfactorily, or during wet seasons when it is desired to dry out the soil, or when the weeds have been allowed to get a start and have become so large as not to be uprooted easily. Where these conditions do not obtain, *i.e.,* on the lighter types of soil which stay more mellow and are more easily worked up; or where the object is to conserve moisture rather than to dry out the soil (and this is more commonly the situation); and when the grower keeps ahead of the work and kills the weeds just as they are germinating, which is the only satisfactory way to handle them; where any of these conditions occur, then either the very narrow tooth or the spike tooth is the best one for the work (Figs. 10 and 49). In order to do the best work the grower ought, therefore, to have one of each type of cultivator on hand, since his conditions as to weeds and moisture are bound to change more or less during any season.

The same general considerations would hold in selecting a two-horse cultivator; one ought either to have two implements, or else one which has two sets of teeth.

For the hill system with close rows, where horse labor cannot be employed, some sort of wheel hoe should be used for as large a part of the work as possible (Fig. 50). These implements are equipped with many different kinds of teeth so that one can use a very narrow set or a heavier set as circumstances may demand. There are also wings for use when one has rather large weeds to contend with, but does not wish to cultivate deeply. For this latter purpose many growers use one of the scuffle hoes (Figs. 51 and 52), and when a man becomes expert with one of them it is surprising what excellent work can be done with it and how little damage is done to the plants. Under most conditions of land and labor, however, the wheel hoe is to be preferred to the scuffle hoe.

Hand Hoes.—Whether the main part of the cultivating is done by the horse cultivator or the wheel hoe, a certain amount of hand hoeing is going to be necessary, and for this work one ought to have several different types of hoes, to suit varying

FIG. 49.—Cultivating the strawberry bed with spikedtooth cultivator shown in figure 10. If this implement is used frequently the amount of hand hoeing will be greatly reduced.

FIG. 50.—Wheel-hoe in use among strawberries grown by the hill system. This implement is a great labor-saver where horse cultivation cannot be practised.

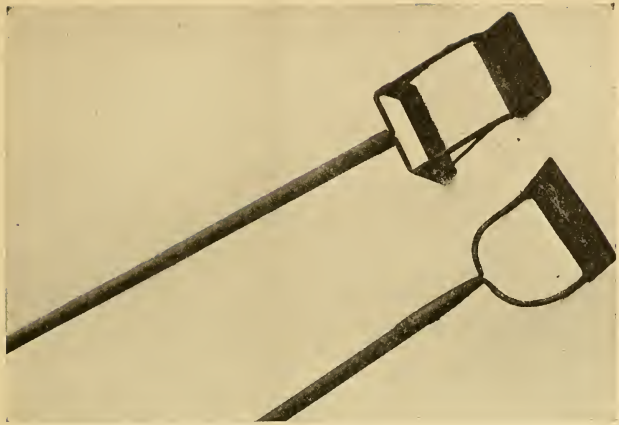

FIG. 51.—Types of scuffle hoes sometimes used in strawberry beds grown by the hill system. A man who is expert in the use of such a hoe can work almost as fast as he can walk down the row.

FIG. 52.—Scuffle hoe, with wheel attachment in use among strawberries grown by the hill system.

conditions. For the earlier hoeing while the plants are still relatively small and far apart leaving plenty of room for the work, a hoe with a wide but shallow blade (Fig. 14) will be found very satisfactory. With such a hoe one covers a great deal of space and does not cut into the ground deeply, but gives the desired shallow culture.

An even better type of hoe for these conditions, unless one has many and somewhat large weeds to contend with, is that shown in figure 14 (next to the right). As will be seen, it has the blade cut up into several broad flat teeth. The great advantage of this hoe, as compared with the ordinary type, is the ease with which it can be used. One can cover the same ground with very much less labor than with the old type of hoe. It will be a surprise to anyone who has never used one of them to see what a difference there is, and the soil is also left in fine tilth by it. Its only defect is that it is not quite so effective with the larger weeds, tending to dodge some of them. But, of course, one ought not to have large weeds in his strawberry bed.

As the plants increase in size and the runners begin to set, so that there is less and less space left for the hoe, a different type may be needed, one with a narrower blade and, in order to get weight, with a deeper blade. Some growers even prefer a triangular blade that will give a fairly sharp point that may be used among the plants (Fig. 14).

The program of cultivating is, of course, going to vary considerably with conditions, but the following will usually be found satisfactory: Begin cultivation just as soon as the bed is set. Someone has said that a horse ought to be kept standing hitched to a cultivator ready to start in the instant the plants are set, and this fairly well expresses the case. The only conditions under which this advice is not sound is where the soil is very light indeed, and the sand may drift over the plants, but it is doubtful if such soil ought to be used for strawberries. Certainly it ought not if better soil is obtainable.

For this first cultivating a heavy-toothed cultivator (Fig. 9) should be used, as the soil will have been made rather compact by the trampling of the men in setting out the plants and needs

a thorough working up. The large teeth also go deeper and tend to more fully "fit" the soil. Moreover, at this time soil moisture may be over-abundant, and some drying out of the soil may be advantageous.

Hoeing After Cultivation.—Immediately following this cultivation the bed should be hoed, using preferably the "rake" type of hoe (Fig. 14). There are two especial advantages of letting this hoeing follow rather than precede the cultivating. In the first place, it gives an opportunity to uncover any plants which may have been covered up by the cultivator, without going over the field especially for that purpose; and in the second place less hoeing is required, since only a very narrow strip is left by the cultivator. This latter point may not appeal to one who has not had experience in the matter, but it is always difficult to get hoers to confine their work to the very narrow strip along the row of plants which will not be reached by the cultivator.

Cultivation in Both Directions.—Where the bed has been marked in both directions so that the plants "row" both ways (Fig. 53), it is possible to use the cultivator both ways during the early part of the season, and thus obviate to a very large extent the use of a hoe.

Keep a Dust Mulch.—In most of the following cultivation the ideal ought to be to keep a good dust mulch to a depth of not over one or two inches, and to leave the surface of the land as nearly level as possible. In order to do this the small-toothed cultivator should be used as far as possible, and used frequently, thus destroying the weeds as they germinate, which is very easily done, instead of allowing them to reach considerable size when it is more difficult to kill them and requires larger teeth on the cultivator, thus leaving the land ridgy.

The exception to the foregoing rule would be where the soil is so wet as to need drying out, or where the weeds have gained some headway, or on heavy soils. In any of these cases the large-toothed cultivator should be selected.

Cultivate After Rains.—The bed ought also to be cultivated as soon after each heavy rain as the soil is in good condition.

Heavy rains, of course, firm the soil down, thus establishing capillary connection between the surface and the soil beneath, and causing loss of moisture. They also drive out the air and render the physical condition of the soil poorer. For these reasons, as soon after the rain or irrigation as the soil has dried out enough so that it breaks up in good condition, the bed ought to be cultivated (Fig. 54).

Cultivation in Dry Weather.—Another point frequently

FIG. 53.—Strawberries grown by the hill-system in a young orchard in Puyallup, Washington. Liberal fertilizing and thorough cultivation are necessary to make such a combination a success.

overlooked is the desirability of cultivating the bed in dry weather, even though there may be no crust on the soil, and no weeds growing in the bed. That is to say, the dust mulch settles down and becomes too compact, even though there may have been no rain since the last cultivation, and it therefore needs an occasional renewing, by means of the cultivator. In this work it is especially desirable to use a cultivator with small teeth so that we may lose as little moisture as possible in the operation of reëstablishing the mulch.

Cultivation to Continue.—Cultivation of the above type, modified to suit local conditions, is continued until heavy frosts or actual freezing weather arrives, or in sections where the ground does not freeze, as long as any of the reasons for cultivation, which have already been discussed, may make it necessary, which in some sections may be practically the whole year.

With the matted-row system the strip cultivated is gradually narrowed as the runners set, until it is not over eighteen inches or two feet in width, which means that the plants occupy

FIG. 54.—Flume for carrying water to irrigate strawberries, Hood River, Oregon. In dry seasons irrigation is a great help even in sections where the practice is not generally common. It brings the berries along faster, thus getting them on the market in advance of competitors.

from one and a half to two and a half feet in width, depending on the distance apart of the rows.

Tillage usually stops with the approach of cold weather and is not again renewed until after the crop has been harvested; then the bed is renovated, as discussed in Chapter XV, and a plan of cultivation similar to that just outlined is carried out. In milder sections, as already suggested, cultivation is carried on during the most or all of the year.

Spring Cultivation.—Occasionally, even in our more northern sections, some spring cultivation is attempted. This, however, is not usually to be advised, largely on account of its expense. In order to do it the mulch (if one has been applied as

is usually the case in these sections) must be taken out of the way while the cultivation is being done. This is usually accomplished by removing the mulch altogether from the bed and returning it again after the cultivating season is over. The alternative is to do one row at a time, taking off the mulch from the first space and cultivating it thoroughly, then putting the mulch from the second space onto this first space and cultivating the second space, and so on across the bed. While this will reduce somewhat the cost of handling the mulch, it is slow and tedious, and allows of only the one more or less thorough cultivation, while if the mulch is removed entirely from the bed for a time, the whole bed can, during that period, be cultivated repeatedly and a much better condition of the soil can be thereby secured.

With the vast majority of growers no attempt at spring cultivation is made, which is fairly good evidence that it is not to be recommended. The aims of this spring tillage are, of course, the same as those already outlined for the earlier tillage, *viz.,* to eradicate weeds and to help the supply of plant food and of moisture in the soil, and it would seem much better to get at these in some other way. It ought to be possible to keep the weeds under control by thorough tillage during the previous season and by pulling out a few of the large ones which may develop the second spring; the plant food can be supplied better and more cheaply by having the soil fertile in the first place and then by supplementing this by an application of commercial fertilizer in the spring. The moisture supply can generally be taken care of if there is plenty of humus in the soil to begin with and if a good mulch is applied to prevent evaporation.

FERTILIZING

There is perhaps no phase of strawberry growing that varies so much as the practice in the use of fertilizers. Some growers use none at all, and other growers are among the most liberal of any class of farmers in their applications. The experimental evidence on the subject is also conflicting and even contradictory.

Most writers on the subject take refuge in the suggestion that "it depends on circumstances," and that "the grower should form his own conclusions, experimenting to find out

what his soil needs." Both of these are safe suggestions, but are rather disheartening to the beginner or to anyone else who wants information.

Principles Involved.—There seem, however, to be a number of principles and practices that are fairly well established and pretty universally accepted. These we may well consider first, and then turn our attention to a few specific cases which will illustrate the practice of successful growers.

1. **Have Soil Fertile in Advance.**—To begin with, all agree that the soil should be very fertile before the bed is set, that no amount of amendments and additions at the time the bed is set and later on can make up entirely for lack of fertility in the soil beforehand. This has already been discussed in the chapter on soils, but can hardly be over-emphasized. It means that the strawberry crop should be planned for several years beforehand if one is to get the best results, and that barnyard manure and leguminous cover crops should figure prominently in the program.

2. **Lime to Grow Clover.**—Secondly it seems to be generally accepted that the strawberry is either indifferent to or is damaged by any large amounts of lime in the soil, preferring, at least, a neutral and probably an acid soil. There are two difficulties in meeting this situation. One is that a clover sod is very valuable in preparing land for the strawberry bed, and clover requires lime if it is to make a growth that is at all satisfactory. To meet this difficulty, apply the lime just previous to the sowing of the clover and hold the clover over for two crops, plowing it under, when the land is finally taken over for the strawberry bed, with as much growth of clover tops as possible. The ideal way is to cut the crop of clover the second year fairly early and then plow down the second crop or "rowen" in the autumn just as it is in bloom. With this treatment all effects of the lime will have disappeared before the strawberry bed is set, and one will get all the benefits of the clover. The only objection to this is that it means an extra year before the land can be reset to strawberries.

The second difficulty in meeting the preference of the strawberry for an acid soil is not so serious and comes only to those growers who want to use wood ashes as a part of the fertilizer

formula. As is well known, ashes carry a relatively large amount of lime, an average content being about 400 to 600 pounds per ton. This, however, is not a large amount, and if the soil is well supplied with humus (which, of course, tends toward acidity) there will usually be no difficulty.

3. **Good Fertility is Lasting.**—In the third place, practically all authorities agree that the need of and benefit from fertilizers is greater the second year than the first. This is just what one might expect, since the first season the soil is fertile to begin with, it has been very well prepared (much better than is possible where the bed is renovated and put into shape for the second crop), and cultivation can be much more thorough since there are, especially during the early part of the season, much fewer plants to interfere.

4. **Need of Nitrogen.**—In the fourth place, nitrogen is universally recognized as the fertilizer element which will produce the most marked results and which must therefore be used with the greatest degree of judgment. The others may not be needed in a given bed, but their presence in excess is very seldom thought to do any damage; and conversely failure to apply them may not lead to such serious results since most soils are naturally well supplied with them. But nitrogen must be had in abundance, otherwise the crop will be cut short. Yet if it is applied in too great quantities, particularly in the form of nitrate of soda, and at the wrong time, particularly just previous to fruiting, more harm than good may result.

Fertilizing Materials.—The most popular materials for the fertilizing of strawberry beds are the following:

Nitrogenous.—*Barnyard manure* is usually held in very high esteem by strawberry men and wherever it is available is generally used more or less.

It has two particularly valuable characteristics for use on this crop. First and most important, it carries a very large amount of humus-forming materials which render the soil mellow and increase its water-holding power, which are both very important considerations. Secondly it is strong on the nitrogen side (which is desirable with strawberries), but is more or less of a complete fertilizer. There is little question that

larger and better crops of strawberries can be grown where some barnyard manure is available than is possible without it. The manure is often applied in advance of setting so that it may become well rooted. This is most important in regions having hot, dry summers.

Green Manure.—Where barnyard manure is not available recourse is usually had to green manure crops which, if the right plants are chosen, have to a certain extent the same characteristics as barnyard manure. Of course, for this purpose some leguminous crop should be chosen. When but a single season, or part of a season, is available for its growth, either soybeans, vetch, cowpeas, or Canada field peas are usually selected. If more time can be had (at least a whole season and preferably two) one or more of the clovers are sown. There can be no question of the value of these crops and they ought to be used wherever possible.

Nitrate of Soda.—For a quick-acting commercial fertilizer nitrate of soda is almost always used. Where it is desired to stimulate growth, as in the case of an old bed that is being renovated when the owner wishes to hustle along the production of new leaves and plants, it will give excellent results. It should be used with care, however, as it produces a luxuriant, soft growth and if used too freely and too near the fruiting period is likely to make the berries too large and soft, and sometimes to reduce the amount of fruit set.

For a more slowly acting fertilizer tankage, dried blood, and cottonseed meal are all used, the latter mostly in the South. The most satisfactory type of growth is likely to be secured by combining nitrate of soda with one of these latter fertilizers, thus carrying growth along more evenly throughout the season.

Phosphatic Materials.—As a source of phosphoric acid probably acid phosphate is the most popular material. The great advantage it has over other materials is that it is reasonably soluble, and is therefore relatively quick acting, and this is generally desirable, particularly where only one crop of fruit is taken from the bed. This solubility is also a valuable characteristic in applying fertilizers to a renovated bed, since there is not the chance here to incorporate the fertilizer with the soil and

one must depend more on the materials being washed down about the roots of the plants.

Bone Meal.—Next in popularity would probably stand bone meal. Some growers will use no other material for phosphoric acid. It is certainly a reliable source and where it is applied to the soil previous to the setting of the plants so that it can be worked into the soil, or where it is used on other crops in a rotation for strawberries, it will be found excellent. It carries some lime, of course, but not enough, nor in such condition as to affect very much the acidity of the soil.

Potash Materials.—For potash, wood ashes and muriate of potash are very commonly used, much more so than any other materials. Where wood ashes of good quality can be had at a reasonable figure they are very commonly used, and a dressing of a ton per acre is usually considered satisfactory.

Muriate of potash has the advantage over the sulfate (which is sometimes used for strawberries and is generally preferred for orchards) as it is cheap and as it will help to overcome the use of lime or wood ashes, if these are applied, since it tends towards acidity of the soil.

Methods of Applying Fertilizers.—*Barnyard manure* is generally applied to strawberry land previous to the season in which the bed is set, and this is decidedly important if the manure is at all strawy. If the crop preceding the berries is such as will be benefited by the manure, then it may be applied to that crop. If manure cannot be used on the previous crop, as in the case of potatoes, then a common custom and a good one is to apply the manure in the autumn and plow it under as shallow as possible, and still get it well covered; then in the spring replow the land considerably more deeply than it was plowed in the fall. This brings the manure (which has in the meantime broken down and begun to rot) just a little below the surface and in exactly the right position for the roots of the strawberry plants.

Well-rotted Manure.—Where very well-rotted manure is used it may be applied in the spring when the land is being fitted for the bed. It may either be spread on the land before it is plowed and turned under, or else be spread after plowing and

worked into the soil. The objection to the former method is that if the land is plowed deeply, as is generally best so as to form as large a moisture reservoir as possible, the manure is buried so deeply that the strawberry plants do not get the best use of it.

Amounts of manure applied will, of course, vary greatly, principally with the amounts of other fertilizers applied and with the fertility already in the soil, but usually from ten to twenty tons (or cords or loads) per acre are considered a good dressing.

If a manure spreader is available it should by all means be used, as the manure can be applied much more evenly. But if not it should be spread as evenly as possible, and in particular all large lumps should be avoided.

With the other fertilizers several different methods of applying are in vogue. When fertilizers are applied the spring that the bed is set, they may be broadcasted and worked into the soil before the plants are set. In this case they are best sown with a fertilizer sower (Fig. 12), but may be broadcasted by hand. Or they may be applied after the plants are set, in which case they are distributed by hand along either side of the row of plants. Sometimes they are spread on the surface of the soil and worked in by the future cultivation and hoeing, and sometimes in shallow furrows opened for the purpose. They are often applied along the row by a hand-operated fertilizer sower (Fig. 13).

The great advantage of applying the materials before the plants are set is that it can be done much more cheaply; while the advantage of putting it on after the plants are set is that all the fertilizer is put near the plants where it can be used by them, while in the other method a considerable part of it falls between the rows where it will be of little or no service to the plants. It is, therefore, largely a question of the cost of fertilizer *vs.* the cost of labor.

Fertilizer Formulas for Strawberries.—As illustrations of the formulas which are used by successful strawberry growers the following may be helpful:

1. 1000 lbs. acid phosphate
   500 lbs. tankage
   100 lbs. nitrate of soda
   400 lbs. muriate of potash

2. 100 lbs. nitrate of soda
   600 lbs. tankage
   1000 lbs. bone meal
   600 lbs. low grade sulfate of potash

3. 500 lbs. bone meal
   250 lbs. tankage
   500 lbs. ashes

4. 1600 lbs. tankage
   1000 lbs. basic slag or bone meal
   400 lbs. high grade sulfate of potash

This last formula is applied one-half within about two weeks after the bed is set and the other half about a month later. It represents the most liberal fertilizing and is only to be recommended where the plantation is given the very best of care in all respects and very large yields are expected.

A 3-7-9 Fertilizer.—The R. M. Kellogg Company, of Three Rivers, Michigan, who are among the largest growers of strawberries in the country, suggest a 3-7-9 fertilizer; that is, 3 per cent. nitrogen, 7 per cent. phosphoric acid, and 9 per cent. potash. These amounts can be secured in various ways, but the following are suggested:

Suggestions for a 3-7-9 Fertilizer

Kind of fertilizer	Principal fertilizer element *Per cent*	Principal element per acre *Pounds*	Amount of fertilizer per acre *Pounds*
Mixture No. 1–1000 pounds per acre:			
Nitrate of soda	15 N.	15	100
Concentrated tankage	12 N.	15	125
Bone meal	23 P_2O_5	70	300
Muriate of potash	50 K_2O	90	180
Total			705
Filler			295
			1000
Mixture No. 2–500 pounds per acre:			
Nitrate of soda	15 N.	7½	50
Dried blood	12 N.	7½	63
Acid phosphate	16 P_2O_5	35	220
Sulphate of potash	48 K_2O	45	94
Total			427
Filler			73
			500

Use fine ground peat or fine ground limestone for filler. The filler may be omitted in either of these formulas without injuring the consistency of the fertilizer, but if this is done proportionately, less fertilizer per acre would be applied; that is, 295 pounds less of the first formula or 73 pounds of the second.

QUESTIONS

1. What is the most important object of cultivation in a strawberry bed?
2. What kind of cultivator would be best to use in a large strawberry bed?
3. Describe the cultivation in the hill system.
4. What is a scuffle hoe? Did you ever use one?
5. What is the best type of hand hoe? Why?
6. Why is cultivation important in a strawberry bed?
7. Why would you cultivate after every rain?
8. Is it necessary to cultivate in dry weather?
9. When would you cease cultivation in your section and why?
10. Would you cultivate a strawberry bed in the spring? If not, why?
11. Would you use lime on a strawberry bed?
12. What forms of nitrogen would you use on a strawberry bed? Why?
13. What kinds of fertilizers are best as a source of phosphoric acid?
14. When and how would you apply fertilizers to a strawberry bed?
15. Give a good fertilizer formula for a strawberry bed.
16. Have you ever used fertilizers on strawberries? If so, what kinds?

CHAPTER XII

OTHER CARE OF THE STRAWBERRY BED

The principal other work on the strawberry bed, aside from that discussed in the preceding chapter, will have to do with the management of the runners. This work will vary according to variety and according to soil conditions, but principally according to the system on which the bed is set.

Objects of Removing Runners.—If the hill system is used, then all runners must be removed throughout the season. One object of this is to allow all of the strength of the original or mother plants to go to the forming of strong crowns, instead of being exhausted in the formation of these new plants on the runners. It also prevents crowding of the plants which further tends towards large, sturdy, prolific crowns. To attain these objects in the highest degree the sooner the runners can be removed after they start the better. This means constant attention to see that the work is not neglected and a good deal of actual labor, but the reward comes, or is expected to come, in the larger and finer berries grown and in the much greater yield.

Methods of Removing Runners.—In the removal of the runners several methods are practiced. Where the work is kept well in hand and the runners are removed before they reach any size and before the runner cords become tough, they can perhaps be pulled off by hand as expeditiously and satisfactorily as in any other way. The principal thing to guard against in this method is to see that the roots of the mother plants are not disturbed by the pulling away of the runners. While the runners are small, as suggested, and if not too many are pulled at one time, there will usually be little danger, but to make sure it is well to steady the mother plant with the other hand.

Use of a Hoe.—An excellent method of removing runners, and one which ought to be used even though it be supplemented by other methods, is to cut them away with the hoe. Whenever any hoeing is done the runners are regarded as weeds and are

cut off and destroyed like any other weeds. Usually this hoeing of the runners during cultivation has to be supplemented by special work with the hoe at other times in order to keep the runners down as thoroughly as they ought to be.

A Dropper.—A third method which is considerably in vogue where the hill system is largely practiced is the use of a special implement called a dropper. It resembles somewhat a post-hole digger, being a circular piece of sheet iron, about four to six inches wide and sharpened to a cutting edge on one side, and with a straight or a cross handle above. Two or three sizes of these are kept on hand for use on the plants at different ages. The usual diameter for the smallest size is eight or nine inches and for the largest size perhaps fifteen inches. Any good blacksmith can make one. The cylinder proper is made of a strip of sheet iron or steel four to six inches wide and long enough to give the required diameter, *i.e.,* twenty-four to forty-five inches long. This is sharpened on one edge, bent into circular form and riveted together. Then two pieces of strap iron are riveted to the upper edge of this cylinder and brought together into a handle above. The whole implement is perhaps four and a half or five feet long.

Of course, this dropper does not do the work as well as it can be done by hand pulling. The runners are not cut so close and some leaves from the mother plants are sure to be cut away. On the other hand, it is more expeditious and it avoids the danger of damaging the roots of the mother plants, so likely to happen when the runners are pulled.

Shears and knives are sometimes used, and the latter in particular have much to commend them. The principal objection to them is that they are hard on the hand of the operator.

Establishing the Hedge Row.—With the hedge systems the first runners to form are usually spaced, that is, placed where it is desired that they should grow, and then bedded or set there. This setting is accomplished in various ways. Sometimes a light trowel is used. Often it is done by hand; and where soil conditions are good, as they should be at this time in the season, this is likely to be the most expeditious way to do the work.

Some growers merely place a clod of earth or a bit of heavy gravel on the runner cord just back of the joint and the runner will then root itself. The first runners are sometimes removed in these systems in order to allow the mother plants to become better established and stronger, but this is of rather doubtful utility since it entails the extra labor and expense, and what is gained in vigor and thrift of the mother plant is lost in the delayed starting of the runner plants.

After the required number of runners have been set (two in the single hedge and four in the double, or more in some modifications of these systems) all additional runners are removed, as in the case of the hill system just discussed.

With the matted-row system usually no bedding or setting of the runners is practiced, the runners being allowed to take care of themselves. In very dry climates or seasons, on poor soils, or with varieties that set few runners, it is sometimes necessary to assist the runners to establish themselves, and when it is the work is done as discussed under the hedge systems. But the removal of superfluous runners from the matted rows often becomes necessary if the best results are to be secured. It is largely a question of varieties, some sorts naturally setting runners very abundantly while others set few. But soil conditions, seasons, and climates also influence it.

Distances Between Plants.—To secure the maximum crops the runners as they set ought to be far enough apart to allow each one space enough to develop a large crown, and to have plenty of air and sunshine during the fruiting season to mature the berries well. Some experiments undertaken by H. F. Hall at the New Hampshire Station gave the results tabulated on page 111.

It will be seen that in this experiment all three varieties gave their maximum yields at six inches apart, and this is perhaps a fair average result, although, like many other matters, it will vary greatly with conditions and varieties.

Prevent Plants from Becoming Crowded.—As a rule, with those varieties that set runners freely, the plants will usually be too thick under the matted row system for the best results, and

Distances Between Plants Influence Yields[1]

Variety	Distance	Yield in quarts per acre		
		No. 1 Berries	No. 2 Berries	Total
Sample.....	Plants 3 inches apart each way...	3521	2146	5667
Sample.....	Plants 6 inches apart each way...	8028	1652	9680
Sample.....	Plants 8 inches apart each way...	6796	1041	7837
Brandywine....	Plants 3 inches apart each way...	1609	1313	2922
Brandywine....	Plants 6 inches apart each way...	4810	943	5753
Brandywine....	Plants 8 inches apart each way...	4963	424	5387
Glen Mary....	Plants 3 inches apart each way...	3458	2354	5812
Glen Mary....	Plants 6 inches apart each way...	6615	1208	7823
Glen Mary....	Plants 8 inches apart each way...	5182	1188	6370

some steps ought to be taken to prevent this. Various methods may be adopted, but the following are some that are often used:

The runners, as they form, are allowed to set as far apart as they will. This means narrowing up the cultivated spaces between the rows by closing up the cultivator so as not to crowd the runner plants back onto the rows. The objection to this is that while it is a cheap method of spacing the plants widely, it adds at once to the area which must be cultivated with the hoe and thereby adds to the expense of culture for the plantation, since the cost of hoeing, if the bed is to be kept in the best condition, as compared to cultivation, is always the big item in the expense account.

Other Methods of Removing Runners.—All the other methods adopted attempt to gain the end sought by destroying the runners after they have formed. And the following are the most common:

1. **Various types of rolling cutters** are used to run along next to the rows and cut off the runners as they form. Sometimes these cutters are separate implements run by hand, but more often they are attached to the cultivator and do the cutting at the same time that the soil is cultivated. The great advantage in their use is that they do the work cheaply. The objections are that a good many leaves are cut from the plants which

[1] Bulletin 137, "Strawberries for New Hampshire."

remain, that the runners are removed in rather a slip-shod manner, and that runners frequently get caught in the frame of the cutter and are pulled off, thus damaging the mother plants.

2. **Hoeing** can be employed as discussed under the hill system and is good as far as it goes, but it is, of course, more expensive than the cutter.

3. **Knives** are sometimes used, and if the removal of runners is to be made a special operation they are perhaps as good as anything, but the method is bound to be expensive.

4. **Removing Plants.**—In the autumn one may go over the bed with a sharp-pointed hoe, such as is shown in figure 14, and cut out some of the plants that have set, or the same thing may be done by pulling out the plants. This is a good but expensive method.

5. **More crude but cheaper methods** of autumn thinning are to use a rake, a weeder, or even a harrow, and go over the bed crosswise, thus pulling out and dragging loose a part of the plants, particularly the younger and more recently set plants along the edge of the row. On large beds where the work must be done as cheaply as possible these methods are often used and frequently with surprisingly good results. They are on the same order as the use of a weeder on various crops while they are young. One is apt to feel while the operation is in progress that a great deal of damage is being done to his plants, but after the thing is done and the remaining plants get back into shape they are apparently as good as ever and the row has been thinned out considerably.

Removal of Blossoms.—Another operation which ought always to be carefully attended to is the removal of all blossoms from the newly set plants. There is usually but one cluster of blossoms to each plant with the ordinary strawberry in our northern sections, but the production of the blossoms and the ripening of the fruit is a severe strain on the young plant, and is an absolute waste of strength since the berries are not abundant enough to warrant one in picking them. The blossom clusters may be nipped off with the thumb and finger, or a pair of shears may be used. The latter method is usually safer and nearly or

quite as expeditious. So far as its effect on the plant is concerned, this work is best done before the blossoms open; and it certainly ought to be done before more than the first blossom has opened, otherwise the plant is put to all the trouble and expense of making the blossom and all we relieve it from is the ripening of the fruit.

With the everbearing varieties, or with the ordinary strawberries in southern sections, where the plants are expected to bear fruit the season they are set out, this removal of blossoms may be carried on only so long as is necessary to allow the mother plants to become well established, or it may be continued longer in order to control the season at which the fruit shall be borne.

Irrigation.—Another operation which ought at least to be mentioned here is irrigation. In some sections this is, of course, a regular feature of the season's work. It is a question whether it ought not to be more often used in sections where the rainfall is usually considered sufficient (Fig. 54). The average season in such sections will see one or two periods (more particularly just before the fruit begins to ripen and towards the end of the picking season) when a good irrigating will increase the crop tremendously.

QUESTIONS

1. Describe a strawberry runner.
2. What is the object in removing the runners?
3. In what ways are the runners removed?
4. How are the runners managed in the hill system?
5. How in the hedge systems?
6. How are they managed in the matted row system?
7. Do strawberry plants become too crowded in the row? If so what are the bad effects on the crop?
8. Under what conditions would you remove the blossoms from strawberry plants? Why?

CHAPTER XIII

DISEASES, INSECTS, AND SPRAYING OF STRAWBERRIES

The strawberry is singularly free from really serious and generally distributed diseases and insects. Of course, there are troubles enough, and some pests, as the white grub and the leaf spot, are very common and often do comparatively great damage. But there is nothing to compare either in destructiveness or wide distribution with the codling moth of the apple, for example, or the brown rot of the peach and plum, or the San José scale which attacks almost all fruits.

It is not the province of a work of this kind to give anything like a complete list of strawberry pests, but the following are some of the more common and destructive of them:

White Grub.—Among insects the white grub stands pre-eminent. There are several closely allied species of them which are known technically as species of Lachnosterna, but practically they are so nearly alike as to be indistinguishable in the larval stage even to experts, and the life histories and general characteristics of them are almost identical. The adult insect is the big, brown, buzzing May beetle or "June bug," which is so attracted by lights and with which we are all familiar.

Life History and Damage.—The female deposits her eggs in the soil, usually about three inches below the surface, and prefers grass land for the purpose, and the older the sod the better she likes it. The eggs hatch in a few days, and the young feed on the roots of the plants growing in the soil and gradually develop into the big, dirty, yellowish-white grubs with a brown head and a blackish tip to the abdomen with which farmers and gardeners are all too familiar (Fig. 55). With the approach of winter they burrow more deeply into the soil and hibernate there, returning the following season to feed again on the roots. It requires one or more years in which to complete the life cycle, but this latter part of their life history does not especially interest us. It is during the second season that they

damage strawberry beds most seriously. Where infested land has been plowed up and set to strawberries in the spring, the white grubs, on coming up from the subsoil where they have passed the winter, find only a comparatively few strawberry roots to feed upon in place of the abundance of grass roots the year previous. They therefore concentrate on the strawberry plants with very serious results.

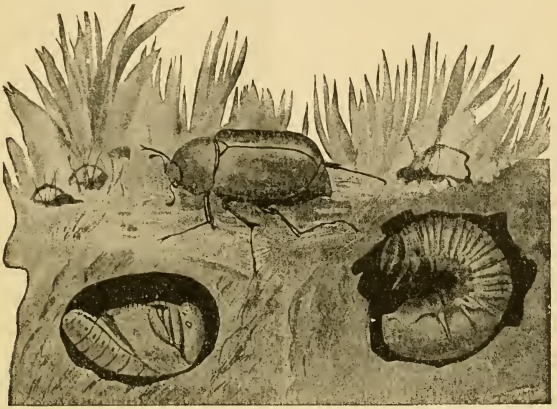

FIG. 55.—White grub shown at right; its pupa at left; adult beetle above. (After Linville, Kelly and Washburn.)

White grubs are also likely to be troublesome where land is kept too long in strawberries. In blocks from which three, four, or five crops are taken they are very likely to damage the bed during the later years.

Prevention and Remedy.—As with a great many other things, the most satisfactory methods of avoiding trouble with them are preventive. Grass land ought always to be avoided if possible in selecting a block to put into strawberries. Occasionally one may escape trouble, but the danger is too great to warrant one in taking the risk if any other land is available. If it is absolutely necessary to use sod land, then plow it very deeply the autumn previous in the hope that the hibernating grubs

may be turned up by the plow where the winter weather will destroy them.

But wherever possible one cultivated crop ought to intervene between the grass crop and the strawberries. Clover is not much affected by the grubs, and a clover sod may fairly safely be plowed down for strawberries.

To avoid trouble after the bed has been established do not keep it down to berries too long. A short rotation with not over two crops of berries and with a cultivated crop the year previous will usually keep them entirely under control.

In case the plants are attacked the only thing that can be done is to dig down by the side of the plant, capture the grub and kill him. This is, of course, entirely practicable for the home plot, but not for a commercial plantation of any size.

Leaf Roller.—In some sections this insect is very destructive and it is very generally distributed through the strawberry sections of the United States and Canada.

Injury and Life Habits.—The adult is a small reddish-brown moth, and the larva (which is, of course, the stage during which the damage to the strawberry bed is done) is a small yellowish or greenish-brown caterpillar. It feeds for a very short time in the open on the upper surface of the leaves and then begins to draw them together with threads and fasten them into a little case, inside of which it continues to feed until it reaches the adult stage. There are from two to four broods in a season according to locality, the larger number being in the South. The insect winters over in both the larval and pupal stages under any convenient trash about the bed, those passing the winter as larvæ returning to the leaves in the spring to feed for a time before changing to pupæ.

Remedies.—There are two lines of attack open. In the first place, the bed may be sprayed with arsenate of lead. Use three pounds of paste or one and a half pounds of powder to fifty gallons of water. This is to kill the caterpillars when they begin feeding. This method is, of course, effective only during the first few days of the feeding of any particular insect and before it has folded up the leaf. After the leaf is folded no

amount of spraying will injure it. The difficulty in employing this line of attack comes from the fact that the different broods are not distinct but overlap each other, so that there are new larvæ appearing constantly. Since there are new leaves appearing all the time, the sprayings must be frequent in order to keep all the leaves protected and thus kill all the insects. To be entirely effective the spraying ought to be repeated every week or ten days. On the other hand, reasonably good and sometimes very good results are secured by spraying just as the first caterpillars appear in the spring.

The other line of attack is in destroying the old leaves on the bed as soon as possible after the crop is harvested. This means that if the bed is to be abandoned it should be plowed under just as quickly as possible; while, if it is to be renovated for another crop, the leaves ought to be mowed and the bed burned off, if this can possibly be done. In either case if the work is thorough the insects of all stages are destroyed.

Short rotations also help, with only one or two crops taken from the bed.

The Strawberry Weevil.—This is another very serious pest in some localities and during some seasons. Some good authorities estimate the loss from its attacks at half the crop during some seasons. It is one of the snout beetles, varying in color from black to reddish-brown and is not over a tenth of an inch in length. It passes the winter in the adult or beetle stage, hiding under any convenient trash, but seeming to prefer woodlands and hedge-rows in the vicinity of the strawberry bed.

In the spring the beetles return to the bed just before blossoming time and feed on the developing pollen. In a short time the female deposits her eggs inside the blossom buds and then girdles the stem below, so that the bud breaks off, thus giving the conditions favorable to the development of the larvæ. Strangely enough, the female seems to know what buds contain pollen and what do not, so that only those varieties which have perfect or staminate blossoms are attacked to any extent.

Remedies.—This brief outline of the insects' habits will suggest the lines along which one ought to proceed in attacking

them. To begin with, everything practicable should be done to eradicate possible winter quarters for them. If avoidable the bed should not be placed in the neighborhood of woodlands or hedgerows, but if this cannot be avoided then all trash about these places should be cleaned up and burned.

The second line of attack consists in planting as freely as possible of the pistillate varieties which are practically immune and only setting what staminate varieties are needed for pollenization, say, every fifth row. For these staminate rows the most profuse blossoming varieties should be selected, so that after the insect has taken its toll there will still be blossoms enough left to furnish pollen for the crop.

Root Louse.—Like most plants the strawberry has its aphis which is sometimes very destructive, working on the roots and causing the plants to become sickly and eventually to die.

The life history is, very briefly, as follows: The eggs, which are small, black and shining, are laid in the autumn on the leaves of the strawberry plants. They hatch in the early spring, producing wingless females which are carried by ants down to the roots of the plants and even from plants which have been killed to fresh plants. They multiply very rapidly, the young being brought forth alive instead of passing through the egg stage, and requiring only about two weeks to reach maturity, when they in turn begin to bring forth young. In the late autumn winged males and females are produced and the eggs laid for another generation.

Prevention.—All of the measures to be used against this pest are preventive, there being no practical remedial measures that can be employed. The preventive measures are as follows:

Set only clean plants in clean soil, that is, soil which is not already infested with this aphis. To be sure of clean plants secure them from a bed that is known to be clean.

This is much better than using plants which are infested and attempting to clean them of aphides before planting. But if the latter method is unavoidable the plants may be cleaned with reasonable certainty by dipping them in a weak solution of nicotine sulfate (tobacco extract), one part to one thousand

parts of water. They must, of course, be thoroughly soaked so that every insect will be wet. To make sure of this the plants ought to be left in the solution for ten or fifteen minutes. Another method which is recommended but which is more difficult to use and less certain to be satisfactory is to fumigate the plants with hydrocyanic acid gas, using the cyanide at the rate of one ounce per hundred cubic feet of space and subjecting the plants to this for ten minutes.

Other Insect Enemies.—There are a number of other insects which are likely to be more or less troublesome, but they are hardly of sufficiently general importance to warrant discussing them in a work of this kind.

Nematodes are really parasitic worms which attack the roots and cause knots or swellings called root galls. They check the growth of the plants and are very destructive in some sections. This trouble may be considered the most serious enemy of the strawberry in eastern Texas, parts of Florida, and on the Pacific coast.

The pest has numerous host plants so that it is difficult to eradicate by means of rotation of crops. Peach and raspberry are often affected and should not be grown with strawberries if nematodes are troublesome (Fig. 56). This is possible, however, if none of the host plants are grown on the land for two or more years. Cowpeas of the Iron variety may be grown during this period.

Treating the soil with a solution of forty per cent. formaldehyde, one pound in fifteen gallons of water, is very effective when applied at the rate of one gallon to a square yard. This method is practical only for home garden patches.

Heavy applications of caustic lime have been found to reduce the trouble materially.

FUNGOUS DISEASES

The one disease which stands preëminently among fungous troubles of the strawberry is the *leaf spot,* which rejoices in the scientific name of Sphaerella fragariæ, or, according to some

authorities, Micosphaerella frageriæ. It is found in practically every section where strawberries are grown.

Attacks of Leaf Spot.—It appears as small purplish spots which sometimes have reddish borders. As the spot gets older the center turns to a grayish color as the tissues are killed. In bad cases the spots run together, forming large, irregular patches which sometimes cover a large part of the leaf. The spots will also be found attacking the stems of both leaves and fruit, being plentifully sprinkled along them. Here they are really more

Crop grown in a young orchard.

serious than on the leaves, since a single spot, if it extends all the way around the stem and proves to be a vigorous infection, may cut off the movement of sap through the stem and thus cause the death of the entire leaf or fruit cluster, and in any event seriously weaken it.

To whatever extent the leaves are attacked their function of producing elaborated food is thereby interfered with, while attacks on the stems of the clusters hinder the development and ripening of the berries, causing them to be small and inferior. In bad attacks of this disease many of the leaves turn brown so that the bed looks as though it had been swept by a fire.

A heavy, wet soil favors the disease, as do also moisture and heat of the air. A period of hot, muggy weather with frequent

showers, to cause a wide infection of the leaves, followed by a dry spell to reduce the vigor of the plants, will often cause a very serious loss, sometimes ruining a bed altogether.

The disease may be controlled by selecting soil suitable to the plants, by frequent changes of the bed, by destroying old leaves, and, in bad cases, by spraying with Bordeaux mixture. One spraying should be given as soon as the plants start in the spring, another just before blossoming, and a third just after blossoming. It is not usually necessary to give all three of these, one application before blossoming being usually sufficient. On the other hand, in some cases the disease cannot be controlled entirely even though all three of these applications are given.

Another great help in keeping this disease in check is to select those varieties which are most resistant to it. There is apparently a wide difference in the behavior of the same variety in different localities. Glen Mary and Marshall are very susceptible to the disease and are, therefore, seldom grown in southern states because of the prevalence of the disease there. In general, a variety which is immune in one section will probably be so in another section. Dunlap, Aroma, Superb, Chesapeake, and Progressive have a high degree of resistance.

Good atmospheric drainage is also very helpful in preventing serious trouble from this disease.

Strawberry Botrytis Disease.—This fungus is sometimes the cause of a serious disease of the strawberry, attacking the stem, calyx, and sometimes the green fruit. It is more serious in rainy seasons, and where such seasons are prevalent during the fruiting time we should plant those varieties which seem most resistant to the trouble. Such varieties are Aroma, Chesapeake, Sample and Superb.

Powdery Mildew.—Another disease which is sometimes troublesome, though not usually so, is the powdery mildew. This causes the leaves to curl up and turn whitish from the mycelium of the disease on the surface. Spraying with Bordeaux as given for the spot will entirely control this trouble. The Belt variety is particularly susceptible to attacks of mildew.

Summary.—It will be seen from the foregoing brief discus-

sion of strawberry pests that most of them, both insect and fungus, can be prevented by the proper handling of the bed. It often happens that no remedial measures are necessary. In fact, probably nine growers out of ten do not attempt any spraying. The campaign for the control of these pests may be summarized as follows:

1. Short cropping of the bed. The more serious the trouble from insects and fungous diseases the fewer crops that should be harvested from the bed.

2. Plowing under abandoned beds just as soon as possible after the last crop is harvested.

3. Mowing over and burning off old beds, which are to be carried over for another crop, just as quickly as possible after each crop is harvested.

4. Spraying with Bordeaux mixture one or more times according to the danger of severe attacks.

QUESTIONS

1. Describe the white grub and its work. Have you ever seen them in the soil?
2. What conditions favor white grubs?
3. Discuss the leaf-roller.
4. Describe the strawberry weevil and its work.
5. Discuss the root-louse. Did you ever see the work of this insect or of any other type of root-louse?
6. Describe the strawberry leaf-spot. Have you ever seen this disease on strawberry leaves?
7. Describe the mildew of strawberries.

CHAPTER XIV

MULCHING THE STRAWBERRY BED

It is usually customary to apply some sort of mulch to the strawberry bed. In the northern sections this is done in the late autumn or early winter, and in the South shortly before fruiting.

Purposes of Mulching.—The principal functions which this mulch serves are the following:

1. **Prevents Heaving.**—It prevents the alternate freezing and thawing of the soil and the consequent damage to the strawberry plants. Strawberries are shallow-rooted plants, with rather delicate, fibrous roots; and when the soil is allowed to freeze and thaw frequently, many of these roots will be broken and others more or less damaged by the so-called "heaving" of the soil. This can be largely prevented by a mulch which causes the soil to freeze and thaw more gradually. This heaving takes place more or less whenever the soil freezes and thaws, but is usually much more serious in the spring. In sections, however, where winter comes on gradually and the soil freezes slightly and thaws again a great many times in the autumn, the plants are likely to be damaged thereby and early mulching is advisable.

2. **Damage by Frost Prevented.**—It keeps the plants dormant in the spring. The principal benefit from this is that it retards the time of blossoming and so will often enable them to escape damage from late frosts which are always a serious menace to the strawberry crop. The blossoms are, of course, very tender; and lying, as they do, close to the ground, they are in a position to catch the frost if there is any. Frequently there will be just enough frost to damage the little central cone of pistils while the rest of the blossom escapes injury. In such a case the center of the blossom turns black while the other parts may remain as fresh as ever.

This retarding of the growth of the plants by means of the mulch must be done with caution, as in case they are allowed to

grow too much under the mulch they become so blanched and tender that they are damaged by the sun when the mulch is finally removed. It is well to examine them from day to day so as to keep track of just how they are coming along and in this way avoid overdoing it.

Delay Makes Later Fruit.—Another point which should be borne in mind in considering this question of retarding the period of bloom is the fact that one also retards the period of the ripening of the fruit. This latter may or may not be of advantage. When early berries bring the highest prices, as is often the case, it would certainly be desirable not to hold back the bed any longer than was absolutely necessary. And on the other hand, in those sections which are far enough north so that their crop comes on the market very late, late enough to take advantage of the upward turn in prices which is sure to come at the end of the season, it is desirable to retard the date of ripening just as much as possible. In the home plantation the late ripening sorts should always be left covered just as long as possible, while the mulch may be removed earlier from early ripening sorts. Even on commercial beds, if the early and late varieties are separated enough so that it can be done, this variation in the removal of the mulch might well be practiced.

3. **Saves Moisture.**—The mulch serves to retain moisture in the soil. This function is performed during the second and following springs, from the time the plants start to grow until the crop is harvested, as during this season there is, of course, usually no cultivation. The importance of this function can hardly be overemphasized in most sections, as it is very rare that a season passes without the plantation suffering from lack of moisture. This mulch acts, of course, just as the dust mulch of a cultivated block does, by holding the moisture under the mulch where it cannot be evaporated by the sun and wind.

4. **Weed Control.**—The mulch keeps down the weeds during this growing period just mentioned. This is another important function. Even though the bed has been kept free from weeds from the time it was set, and even though the previous treatment of the soil has been such as to reduce to a minimum

the weed-seed present in it, there are always plenty of them left, and the mulch has to be relied upon largely to prevent their competing seriously with the strawberry plants.

5. **It Keeps the Berries Clean.**—Without a good mulch the dirt is sure to be spattered up on to the berries during rains so that their value is very decidedly reduced. The fruit from unmulched beds is less attractive on account of this dirt on it, and even when it has been thoroughly washed there is frequently more or less grit left on it. Store-keepers and market men who handle strawberries are almost certain to inquire, when they are approached to see if they will buy the crop from a certain bed, whether the bed was mulched or not. If it was not, they are never as anxious to buy and will usually not pay as much for the output, frequently by several cents per quart.

6. **Picking Conditions Improved.**—It improves the conditions of the bed at picking time, enabling the pickers to get about more comfortably, particularly when heavy rains come during the picking season. It also prevents the soil from being trodden down quite so firmly by the pickers and therefore makes it possible to renovate the bed much more easily and satisfactorily than if there is no mulch.

7. **It Prevents the Soil from Baking.**—This is especially important during the picking season when the trampling back and forth of the pickers day after day firms the soil down seriously at best. The mulch helps to reduce this solidifying of the soil which without it would materially reduce the crop and leave the soil in bad condition for future crops.

8. **The mulch may improve the soil** by adding a certain amount of plant food and humus. This is particularly true where strawy manure is used, but any mulch material breaks up more or less and some of it is worked into the soil, thereby improving it.

One Danger.—On the other hand, the one damage to the plantation which is likely to result from the use of mulch is that it increases the danger from frosts in the spring. Everyone is familiar with the fact that when a light frost occurs it will be found on straw or hay more surely than anywhere else. This

is no doubt due to the straw preventing the heat of the soil from being given off to the air above it. While the margin is a narrow one, it might easily cause a frost to occur on the mulched bed while it would not on the unmulched one.

MATERIALS FOR THE MULCH

It is often difficult to get materials that are entirely satisfactory for mulching. This, of course, is particularly true where large beds are grown, but even on relatively small beds the problem of securing a material for mulching that is satisfactory in all respects is often a difficult one to solve. Generally it ends in a compromise. Some of the important characteristics of a good material for a mulch on strawberry beds are:

1. **That it be Cheap.**—This needs no discussion, but is frequently the most difficult requirement to fulfill.

2. **No Weed Seeds.**—It shall contain no seeds of weeds that would germinate and grow in the bed. Some plants would never become troublesome in a strawberry bed and their presence in a mulch would therefore not be objectionable, while other plants, like the various types of pig-weed, chickweed and others, are always to be guarded against.

3. **Not Easily Blown.**—It shall not be too easily moved by winds. There is almost always more or less trouble from the mulch being blown off during the winter and early spring by heavy winds. On small patches this can be prevented by placing boughs on top of the mulch, but on larger plantations this is, of course, out of the question, or at least very expensive, and the character of the material must be relied upon to keep it in place.

4. **Not Smother Plants.**—The material must not be compact enough so that it is likely to flatten down on the ground and smother out the strawberry plants. This is the objection to the use of leaves from such deciduous trees as the maple.

5. **Compact.**—On the other hand, the material must be sufficiently compact to conserve moisture and keep down the weeds.

6. **Easily Applied.**—Lastly, the material must be such as

will spread evenly and with a reasonable degree of ease over the bed.

Most Suitable Materials.—Now, like a great many other ideals, the ideal material for mulching a strawberry bed does not exist, but some materials approach it more or less closely. The following are most often used:

1. *Marsh hay, swale grass and other similar materials.* These are generally very satisfactory where they can be had, as they do not usually contain weeds which will grow on the type of soil where strawberries grow, and they have most of the other characteristics of a good mulch. The difficulty is that they cannot usually be had in sufficiently large quantities and in many sections not at all. Occasionally they may contain troublesome weeds, in which case they must be cut early before the seed matures enough to germinate.

2. *Straw* (oats, wheat, barley, or rye). This is more commonly used than any other material, and where it is free from weed seed comes as near the ideal as we can get. Unfortunately, as every farmer knows, grain fields are pretty apt to have weeds in them, and we apply their seeds along with our mulch often with disastrous results the following spring. But straw fulfills as many of the requirements of a mulch as perhaps any other material we have and is more commonly used than any other.

3. *Strawy Manure.*—This makes an excellent mulch and at the same time adds a good amount of excellent plant food. The two objections to it are that it is usually available in only limited quantities and that it is likely to carry more or less weed seed.

4. *Corn Fodder.*—This is too coarse to be really satisfactory in many ways, but this very fact makes it particularly good where severe winds have to be contended against. It carries no weed seed, and if enough of it is used it is reasonably good mulch material. It is generally rather expensive and is not used very commonly except on rather small blocks.

5. *Pine Needles.*—These make an excellent material, being almost ideal except that they are rather compact. The objection to their use comes from the fact that they can frequently be had

in only limited quantities, and that the pine forest is damaged by their removal. Yet in sections where pines are abundant they are often used. Leaves of other trees may form at least a part of the mulch, though not too large a part, as they are likely to mat down and smother the plants. Stalks or other material may be needed to hold the leaves from blowing.

6. *Growing a Mulch on the Bed.*—This is a fairly common practice, the plan being to sow oats, barley, or some other crop in late summer or early autumn in time for it to make a considerable growth before frost kills it. The objection to the practice is that it necessitates stopping cultivation relatively early, thereby reducing the supply of moisture and plant food, and introducing a plant which will compete with the strawberry for this lessened supply. Moreover, this mulch is grown only between the rows, and it is still necessary to apply more or less on top of the rows. Of course, the advantage of the practice is that one utilizes the strawberry bed for the growing of the mulch.

Planning for the Mulch.—Many growers make a practice of growing some crop on other land in the late summer especially for use as a mulch. The larger growing plants are generally used, such as corn or millet or sorghum, and are sown thick enough so that they do not become too large to be satisfactory, and late enough so that they do not mature seed. Corn, Japanese millet, or sorghum is most commonly used, and the practice is a good one where land is available, and where some other kind of material, such as straw, cannot be had, which yields some other return along with the mulch.

The date of applying the mulch will vary with the climate and also somewhat with the size of the plantation. The principal question, so far as the welfare of the bed is concerned, which decides the date of application, is the freezing of the soil. Somewhat better results are secured if the ground freezes fairly solid before the mulch is applied. On the other hand, if the soil freezes and thaws repeatedly before it is finally frozen solid the plants are thereby damaged and the mulch ought to be applied earlier.

How Applied.—In large-sized plantations it is necessary to

drive on the bed with the loads of mulch (Fig. 57), and, if possible, this ought to be deferred until after the surface of the ground has frozen solidly enough to hold up the team, otherwise

FIG. 57.—Applying the mulch to a large strawberry bed. R. M. Kellogg Co., Three Rivers, Mich.

FIG. 58.—Mulching the strawberry bed after snow has fallen. An advantageous method if the snow is not too deep as it assists in getting an even distribution of the mulch.

considerable damage will be done to the bed by horses and wagon. Of course, as suggested above, where winter comes on very slowly this work cannot usually be deferred so long, as the alternate freezing and thawing of the soil before it is finally frozen solid may do much more damage to the bed than the teams would do.

On smaller plantations the material for mulching should be dumped in piles around the sides of the bed and then be carried to the bed with forks (Fig. 58). This makes it possible to apply the mulch at any time that is desired.

Where rather fine material is used for mulching, it may often be applied very satisfactorily with a manure spreader.

Quantity.—Only a light coating of the mulch is necessary, as it is not expected that it will prevent the soil from freezing, but

FIG. 59.—The strawberry bed under its winter mulch. An even but moderately light application is best.

merely cause it to freeze and thaw much more slowly, so that during a short mild spell it remains frozen. A layer of mulch from one to two inches in thickness will be ample for all purposes and will avoid any danger of smothering the plants which sometimes happens when the mulch is applied too thickly. In general the finer the material the less of it should be applied.

Uniformity.—The mulch ought to be uniform in thickness over the entire surface, between the rows as well as on top of them; but if there is a scarcity of material and it becomes absolutely necessary to economize somewhere, the rows are, of course, more important than the spaces (Fig. 59).

It requires some care to secure uniformity of thickness, par-

ticularly with materials which have been stacked up for some time and have thereby become firmly matted together. They should be well shaken out in applying so that the solid lumps of the materials may be detected and broken up.

In Windy Places.—Occasionally in very windy locations it becomes necessary to anchor the mulch in some way, and some sort of boughs thrown on top of it is the best plan. If the windward side of the bed and the most exposed sides of any slopes can be held in place in this way it will frequently result in keeping the whole bed in pretty fair shape.

In cases of this kind, it is, of course, desirable to use the coarsest materials for mulching, and here, if anywhere, such materials as corn stalks or sorghum would be useful.

Removal Time.—In deciding when to remove the mulch in the spring, two points in particular must be borne in mind: First, that the mulch must stay on as long as it is needed to protect the plants from danger by cold, and second, that it must not stay on so long that the plants will grow under the mulch and thus be injured when the mulch is removed and they are exposed to the light. There is usually no difficulty in meeting both these requirements.

To meet the first point, the mulch ought to be allowed to remain on the bed until all danger of any great degree of freezing and thawing has passed. A fairly good rule is to leave it on until there is no likelihood of the thermometer going as low as 20 degrees above zero. If it does not go lower than that there is usually no damage to the plants. To meet the second requirement one should examine the bed from time to time and see how the plants are coming along and get the mulch off in time. Of course, in the final analysis it depends on "the weather man" whether there is any severe freezing after the plants have started to grow, but usually he is "accommodating enough" so that there is not.

Another point to be kept in mind in deciding when to remove the mulch is whether one wants early or late berries. If early berries are very desirable, as they often are, it is worth while to run some risk of damage by cold in order to get the

mulch off early and thus start the plants into growth. Some growers even go so far as to leave the winter mulch off altogether on this account. On the other hand, where late berries are wanted the mulch should be kept on as late as possible and still not run any great risk of damaging the plants.

How to Remove Mulch.—In the actual removal of the mulch various methods are used. Where no spring cultivation is attempted, which is the practice of the great majority of straw-

Fig. 60.—Opening the mulch over the rows in the spring. The less the mulch can be disturbed and still insure the plants pushing through, the more effective the mulch will be in keeping the briers clean, keeping down weeds and preventing loss of moisture. The straw is sometimes parted with a hay fork.

berry growers, the mulch over the rows should be opened up only enough to allow the plants to push through. The more mulch we can retain and still get the plants through, the greater the benefit we will get, in retaining moisture, keeping down the weeds and keeping the berries clean. If only a light mulch has been applied it is generally sufficient to send men over the bed and merely part the mulch a little over the plants. This is usually done with the hands (Fig. 60). Where more mulch has been applied some of it may be removed from the rows and placed between them. Usually no mulch is taken entirely off the bed, and it is better not to do so if it can be avoided.

The method of handling the mulch when spring cultivation is practiced has been discussed in the chapter on cultivation.

QUESTIONS

1. How much can a crop of strawberries be retarded by a mulch? Have you ever seen it done?
2. What are the advantages of this practice?
3. What are the dangers from its use?
4. How and why does a mulch affect the moisture in the soil?
5. What do you consider is the most important single function of a mulch?
6. What materials have you seen used as a mulch on strawberry beds?
7. What material is most commonly used in your section? Do you think it is a good one?
8. What do you think of the plan of growing a mulch on the bed?
9. When is the mulch applied? How?
10. When is the mulch removed? How?

CHAPTER XV

RENOVATING OLD STRAWBERRY BEDS

The practice of different growers varies greatly as to the number of crops harvested from a strawberry bed. Many northern growers find it cheaper and better to set a new bed each year and plow under the old one after the fruit is harvested. Others renovate the old bed and grow a second crop. And this process of renovating is repeated year after year by a few growers until as many as four or five crops have been grown. Beds last from two to five years in the southern states. In the extreme West the beds are kept for several years.

Number of Crops.—For the most part, however, the question lies between growing one or growing two crops on the bed. Those who advocate one crop claim that it is cheaper to fit new land and set out new plants than it is to renovate the old bed; and, moreover, that there is much less danger from diseases. The advocates of two crops say that if properly done the renovating is not as expensive as setting a new bed, that the fruit ripens earlier and that frequently a larger crop is raised.

Like many other questions, this one, no doubt, depends on circumstances. If the bed has been well cared for during its first year, particularly in the matter of keeping the weeds under control, if fungous diseases have not developed, or if spraying has been done to prevent them, and if the soil is fairly light so that it can be brought back into good physical condition without too much labor, and furthermore, if early berries are desired, then probably a second or even a third crop may be grown to advantage. But if these conditions do not obtain then it is probably better to take off a single crop and plow up the plantation.

Methods of Renovation.—If the bed is to be renovated several general methods may be used, but the following will be found a satisfactory plan:

Mowing and Burning.—First mow over the bed either with

a scythe or a mowing machine, depending on the size of the bed. If the machine is used, tilt the cutter bar so as not to mow the vines off too short. After mowing, these old leaves, together with the mulch applied the previous autumn, may either be raked up and hauled off the bed and then burned, or they may be allowed to dry and then the whole bed be burned off, or they may be raked in between the rows and burned there. Probably the second plan is the ideal one if it can be handled just right, but two difficulties are likely to be encountered; either there will be so many green strawberry leaves and weeds left that the old bed will not burn, or else, if the mulch has been plentiful, there will be so much of this and the dry leaves combined that the fire will be so hot as to injure the crowns of the plants one wishes to save. If this method of burning is to be practiced it is well to go over the bed with a hay tedder to stir up the mulch and old leaves so that they will be more evenly distributed and will dry out better. The two great advantages of this method over the others are that one saves all the ash from the burned leaves and mulch, which ash is distributed uniformly over the bed, and second, that insects and their eggs and fungous spores are more thoroughly destroyed.

Fresh Tilth.—Having disposed of the old leaves and mulch, the next operation is to stir up the soil and get it back into good tilth to stimulate growth of the plants that are saved and to provide good conditions for the new plants which will develop from the runners sent out by those plants. The simplest method, but usually the least satisfactory, is to use a cultivator with large heavy teeth and go back and forth repeatedly between the rows, loosening up the soil and tearing out the plants from the sides of the rows until only a fairly narrow strip of the old plants is left (say eight to fifteen inches), and until the soil is in reasonably good physical condition again. With light soil which is not too dry, it is surprising into what satisfactory condition the soil can be brought by this method. Yet it does not, of course, stir the soil as deeply as plowing. One should not expect to finish the work at a single session, but return to it several times, after intervals of two or three days.

Plowing under Plants.—It is, however, usually better to employ a plow, preferably a small one, for this preliminary work of breaking up the soil. The first question to decide is what part of the old row shall be saved. Theoretically it is better to save one edge of the row because this insures getting rid of all the old plants that were set out the year before and retaining only those which grew as runners the previous season. But practically this advantage may be more than offset by the fact that the edges of the rows are likely to have a good many weeds in them while the center, where the foliage of the strawberry plants has been the most dense, is comparatively free of weeds. If one decides on retaining the center, the simplest thing to do is to turn one furrow from each side into the space between two rows (Fig. 61) and then with a cultivator (Fig. 62) work down the soil thus turned up until it is in good condition. The alternative of this plan is to use a swivel plow and begin at one side of the bed and turn all the furrows in one direction, but retaining, undisturbed, the center of each strawberry row. While this may leave the bed looking better when the plowing is finished, it does not usually work out quite so well as the other plan.

If it is decided to save a strip of plants along one side of the row instead of in the middle as just discussed, the plowing can be done much as outlined above, except that the first furrow should be plowed along the center of the old strawberry row which will root out the oldest plants, and then a return furrow plowed against this from the middle of the old original space.

Cultivation after Plowing.—When the plowing has been finished the soil which has been thrown up by the plow should be worked down into fine condition, using a cultivator with large teeth, and going over the bed repeatedly as outlined for the work where no plowing is attempted.

Fertilizer.—Some fertilizing ought to be done at this time to start the old plants into renewed growth and in particular to stimulate the production of runners. A fairly heavy application of well-rotted barnyard manure (say fifteen cords per acre), when this is available, will be found admirable. But as this is

FIG. 61.—Plowing to renovate an old strawberry bed. One furrow is turned from each side of the old row into the space between the rows.

FIG. 62.—Following the plow with the cultivator in renovating a strawberry bed. The larger-toothed cultivator best.

frequently not to be had, it is usually necessary to rely on commercial fertilizers. Formulas recommended vary greatly, partly because conditions vary and partly because men's ideas of what is necessary vary. The following will be found satisfactory under average conditions, the amounts given being for an acre:

FIG. 63.—Sowing fertilizer on a renovated strawberry bed. The bulk of the fertilizer should go on the rows and not between them.

100 lbs. Nitrate of Soda
250 " Tankage
400 " Acid Phosphate

750 lbs. per acre.

Or, if tankage is not available:

250 lbs. Nitrate of Soda
400 " Acid Phosphate

650 lbs. per acre.

To either of these may be added to advantage in normal times two hundred pounds of muriate of potash or an equal amount of high-grade sulfate of potash. Fifty bushels of unleached hardwood ashes make an excellent substitute for the above potash at any time.

How to Spread Fertilizer.—Whatever the fertilizer applied, whether barnyard manure, commercial fertilizer, or wood ashes, the bulk of it ought to go along the rows and not between them. This can be accomplished best by using a hand-distributing machine or by applying the materials broadcast by hand (Fig. 63). In either of these methods, while the bulk of the fertilizer will go on the row, enough of it will fall by the side of the row to amply provide for the new runners which will set later. A horse-drawn fertilizer sower is sometimes used for this work, or the fertilizer is sown by hand between the rows or over the entire surface. The objection to either of these methods is that a large part of the fertilizer falls in the cultivated strip between the rows where it is of little value to the growing plants, as strawberries do not forage very widely.

FIG. 64.—Hoeing the renovated strawberry bed. A sharp-pointed hoe, such as is shown at the extreme left in figure 14, will be found best for this work.

Time of Spreading Soluble Fertilizers.—In applying commercial fertilizers one should be careful to select a time when the plants are thoroughly dry, as any dampness will cause the nitrate of soda and other readily soluble materials to go into solution, and if this happens on the leaves or among the buds the tissues are likely to be seriously damaged.

Hoeing.—Either before or after the fertilizer is sown the strip of plants which has been saved should be given a thorough hoeing (Fig. 64). Here is another point where the practice of different growers varies greatly. Sometimes no hoeing is done except such as is necessary to root out the weeds, and in other cases plants and weeds are hoed out for a space of a foot or so in the row, then an equal space is left with the strawberry plants in it, then another hoed space, and so on. If the renovation is

FIG. 65.—Plowing down the old strawberry bed. Beds are abandoned most often on account of weeds. Compare with figure 66.

FIG. 66.—Crop of buckwheat following a crop of strawberries. Same bed as shown in figure 65.

done at once after the crop is harvested, so that there is still ample time for the remaining plants to send out new runners, probably the last mentioned method is best. But where the time for runner production is short, more old plants should be retained to take part in the operation and to furnish, in themselves, fruiting plants for the next season.

From this point on the treatment of the renovated or renewed bed is the same as for one newly set.

Cost of Renovation.—As an indication of the cost of renovating a strawberry bed the following figures may be of interest. They are the actual cost for a bed of almost exactly an acre:

Mowing old leaves—man and team, 1½ hrs. @ 70 cents	$ 1 05
Raking, man and horse, ½ hr. @ 50 cents	25
Hauling of leaves, man and horse, 2 hrs. @ 50 cents	1 00
Plowing and cultivating first time, 21 hrs. @ 50 cents	10 50
Sowing fertilizer, 4 hrs. @ 25 cents	1 00
Hoeing, 45 hrs. @ 25 cents	11 25
Cultivating, second time, man and horse 6 hrs. @ 50 cents	3 00
Total for one acre	$28 05

There is, of course, no cost for plants in this method. This is always a considerable item of expense in a new bed and probably ought to be charged up even though the plants may not be bought but secured from another bed on the place.

When the bed is finally abandoned it should be plowed under (Fig. 65) as quickly as possible after the last crop of fruit is harvested, and the land either sown to a cover crop or some such crop as late cabbages grown (Fig. 66).

QUESTIONS

1. How many crops of fruit are generally taken from a strawberry bed?
2. What are the arguments in favor of taking only a few crops?
3. How many crops do the best growers in your section take?
4. Why and how are the old leaves destroyed when one renovates a bed?
5. Describe the plowing, in the process of renovating a strawberry bed.
6. How is the soil treated after the plowing?
7. What fertilizers are used on the renovated bed and how are they applied?
8. What hoeing is necessary in renovating a bed?
9. Give the approximate cost of renovating an acre of strawberries. What are the most expensive items?
10. Do you think it would be more profitable to set a new bed or renovate an old one?
11. Did you ever renovate a strawberry bed? If so, were you satisfied with the returns?

CHAPTER XVI

HARVESTING AND MARKETING STRAWBERRIES

It is generally agreed that the crucial point in making a crop of strawberries profitable comes at the very end, when one attempts to harvest and market them. More men fail here than anywhere else. It introduces new and entirely different problems. There is more help to handle, and it is a different kind of help. There are decisions to be made and made quickly. And a mistake cannot be remedied as it can in the earlier work on the plantation.

Preparation.—One of the most important points in handling the situation satisfactorily is to have everything in readiness beforehand, crates and baskets on hand, pickers engaged, quarters ready, and markets looked up.

The labor question is always a serious one. It is difficult to have enough help in the height of the season and not too much when the picking is more slack. In particular it is difficult to hold the pickers to the end of the season. But with proper forethought this can usually be accomplished. Like everything else, if met in time, a good many of the difficulties will disappear.

Women Pickers.—As a rule, women who are accustomed to outdoor labor make the very best pickers. They are deft, rapid, careful, and interested in getting the work along. If it is not possible to get all women for the picking crew, a few of them will tend to steady the rest of the pickers and make things go more smoothly.

Men of the right type will do well where the picking is good, but they are usually not so rapid workers as women and not quite so easily managed.

Boys and girls, from ten years up, are most commonly used as pickers, but are naturally, as a rule, least satisfactory. They play more, pick less, tire more quickly, and are more apt to want to pick lying down. A few children mixed in with adults

will do very well, but an entire crew of them is open to serious objections.

Whole Families.—Where the areas to be picked are large, and particularly where other fruits follow strawberries so that the work on the place will continue over a long season, it is often possible to get whole families to come and settle down for the picking season, which makes an excellent arrangement.

Number of Pickers Needed.—In any case, the pickers ought to be engaged as early in the season as possible, and just as definite an agreement made with them as possible. The number needed per acre will vary greatly according to the crop, the pickers' ability, whether it is the height of the season or not; but for an average crop four or five good pickers will usually handle an acre.

Prices paid vary with the locality, the season and the pickers, but two cents per quart is the most common rate. An excellent way to hold the pickers through to the end of the season is to offer a bonus for those who stay till the work is done. Some growers pay one and one-half cents and make it up to two cents at the end of the season if the picker has stayed right through.

Income for Pickers.—It ought to be said right here, though perhaps it hardly needs to be mentioned, that nothing will do so much towards keeping the pickers happy and contented as to have a good crop of fruit for them to pick. In good picking, even at two cents a box, an expert picker will frequently make from three to five dollars per day, and much higher records have been made; while with small berries and few of them, the day's wage is correspondingly lower and the picker correspondingly disheartened.

Management of Pickers.—In the management of the pickers in the field the following points will be found helpful:

1. **Assign each picker** to a special row or rows. This is vital to success, and if the same row can be assigned to a picker right through the season, so much the better. Where this is done there is no chance for dispute as to who was responsible for poor picking.

2. **A Field Boss.**—If the operations are at all large there

ought to be a field boss who shall keep track of the picking, see that it is well done, keep the records of how many are picked by each person, etc.

3. **Record Cards.**—In keeping tally on the number of boxes picked, the most satisfactory plan is to use a card such as is shown in figure 67. Two such cards ought to be used for each picker, one to be kept by the foreman and the other by the picker. Then when a carrier full of berries is brought in by the picker, the foreman places the two cards together and punches out

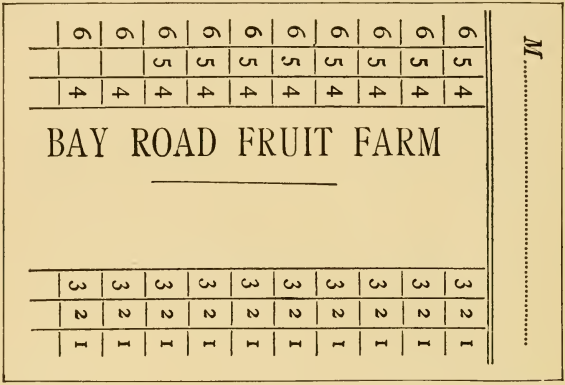

FIG. 67.—Berry picker's card used in keeping tally of the number of boxes picked.

(using a regular conductor's punch) a number equal to the number of boxes brought in. Under this arrangement there is no chance for dispute, each side has a card and the two are, or ought to be, exactly alike. If only the foreman has a card, then the picker is apt to think that he has forgotten to punch for some baskets; and, on the other hand, if there is only one card, and this is held by the picker, there is always the danger that some other punch than the foreman's may be used on it.

4. **Carriers. Give Each Picker a Carrier.**—This should never hold more than six baskets, and a four-box carrier has the advantage of being lighter to carry and of exposing the berries a shorter time to the sun and heat while the picker is filling the

boxes. Several types of these carriers are shown in figures 68 to 72. Those with legs have the advantage that if they are set down on the row they are not so likely to bruise the berries on the vines as are those without legs.

5. **Degree of Ripeness.**—Be careful as to the degree of ripeness of the berries when picked. If they are for nearby markets

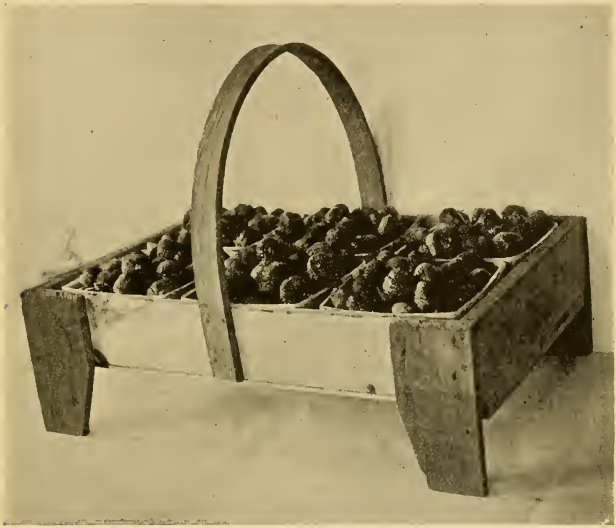

FIG. 68.—A six-basket carrier with legs. This has the advantage of not mashing the berries on the vines if the carrier is set down on the row.

or if the weather is cool, they can be allowed to get more nearly ripe than they can for distant markets or in hot weather. For a really local market, where the berries are eaten the same day they are picked, they should be allowed to get fully ripe on the vines. They are never quite so good when they have to ripen after picking, and this is one of the advantages which the local grower has over his more distant rival. It explains why the price of berries at once goes up when the first "locals" come

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in. There is a good business for any man who will grow good berries for even a small local market.

As the distance to market increases the degree of ripeness must decrease. For distant markets three-fourths ripe is as mature as they should be to stand shipment well. And it ought always to be kept in mind that of the two extremes, under-ripeness is much to be preferred to over-ripeness.

FIG. 69.—A handy type of field berry carrier. The small size makes it light to carry, and the berries are not exposed so long to the heat while the pickers fill the boxes.

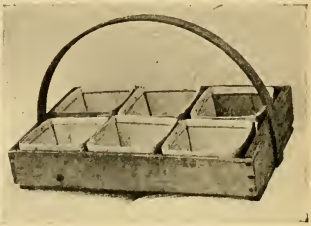

FIG. 70.—A good type of field berry carrier.

FIG. 71.—A six-basket carrier for field use A strong type not easily broken.

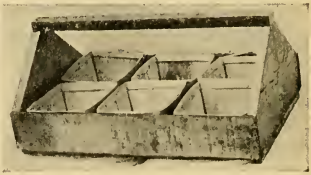

FIG. 72.—A convenient type of field berry carrier.

6. **Keep the different varieties separate** as they are picked. In any bed there are likely to be two or three varieties, at least, and the market will handle them better if each sort is put into crates by itself.

Rules for Pickers.—It will assist very materially if the pickers are thoroughly coached at the start on how the fruit should be picked and are given a set of rules, either orally or printed on a card, suggesting just what is desirable and what is

not. The following are some of the important points to be included in such rules:

1. **Stem and Calyx.**—Always pick with the calyx and a small piece of the stem about a quarter of an inch long attached to the berry. If the hulls are pulled off the flesh is sure to be bruised more or less, which causes the berries to wilt and in time to begin to decay. Moreover, the hulls act as a packing to keep the berries in good condition in transit.

2. **Clean Picking.**—Pick the row clean. Berries too small or poor to be marketed should be picked off and dropped on the ground. Nothing is more disastrous than to leave some ripe berries at one picking, for they become over-ripe and soft before the next picking, and unless they are discarded then by the picker they will ruin the whole box.

3. **Fill the Baskets Full.**—It ought not to be necessary to fill up the baskets at the packing shed, and if the pickers are started right at the beginning and told that this rule will be enforced, there will usually be no trouble. The grower ought to to get pay for nearly as many quarts as he pays to have picked, but in actual practice there is often an alarming shrinkage due to these scant baskets from the pickers.

4. **Avoid Bruising.**—Do not hold more than two or three berries in the hand at one time. If more than this number are held they are sure to be bruised.

5. **Place the berries in the box**—do not throw them in. Strawberries are very tender and a little bruising at picking time may be a serious matter by the time the housewife gets the berries.

6. **Grading While Picking.**—With adult pickers it is possible to have the berries separated into two grades as they are picked which, while it may not be final, will at least help materially in the later grading.

Equipment.—In the matter of equipment it is very desirable, as already suggested, to have everything in readiness in plenty of time. The boxes and crates ought to be ordered a long time in advance, partly to make sure of having them when wanted, and partly because they are almost certain to advance

in price later in the season. As a rule, it is better to have nothing but clean, absolutely fresh stock. This is *always* true with the baskets. With the crates it is sometimes possible in local northern markets which have shipped in a good many berries from the South to pick up good clean ones that are entirely satisfactory and much cheaper than new ones would be. But good quality baskets and crates that are clean and attractive ought always to be provided. If these arrive some time before they are to be used, they should be stored away in a dry and dark place, as they discolor quickly if exposed to the light.

In addition to these, there should be plenty of carriers in readiness, besides pickers' cards, a punch for the foreman, rubber stamps, etc.

A Packing Shed.—In a convenient spot near the berry field a packing shed should be erected where the berries can be sorted and packed and where a limited supply of baskets and crates may be kept. Figures 122 and 123 show types of these sheds. The roof must be tight enough to shed rain and the sides should be open, with a shelf or table around the outside, on which the berries may be placed as brought in by the pickers. A shutter, which can be dropped down in case of a sudden shower accompanied by wind, is very desirable on the side or sides from which such showers are likely to come. But if there is a good overhang to the roof this will do almost equally well.

Harvesting Operations.—In the general management of the harvesting operations the following points are worthy of consideration:

1. *Frequency of Picking.*—As a rule, the bed should be picked over every day. At the beginning of the season, while ripe berries are still scarce, and at the last end when the berries are running smaller and fewer, it may do very well to pick every second day, but in the height of the season much better results will be secured by daily pickings.

2. *Pick when Dry.*—If possible, avoid picking when the berries are wet. For nearby markets this rule may be disregarded, but for fruit which has to be shipped it is almost cast iron. Moist berries simply will not stand up in transit

and are sure to decay. Even for local markets wet berries are not attractive.

3. *Keep Berries Cool.*—Keep the berries as cool as possible. Have them brought in promptly by the pickers and never allow the crates or carriers with berries in them to stand out in the sun. The shade of even a small tree is helpful (Fig. 73).

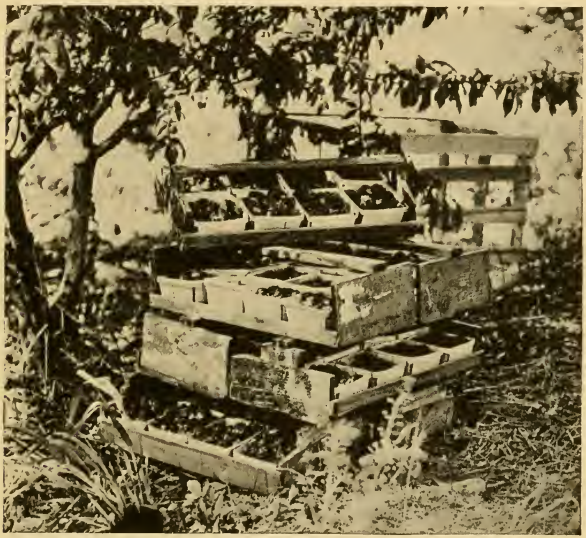

FIG. 73.—Crates of strawberries placed temporarily in the shade of a small tree. Nothing damages berries more quickly than allowing them to stand in the sun.

4. *Clean Crates.*—In handling crates and boxes about the field or the packing shed be careful that they do not get soiled. Nothing detracts from the appearance of strawberries so much as dirty boxes and crates.

5. *Hauling.*—If the berries are hauled from the field to the packing shed, and when they are hauled from the shed to the car or to market, a truck or wagon with good springs should

always be used. The truck shown in figure 15 will carry anywhere from one crate to a hundred on an "even keel," and with absolutely no jarring to hurt.

Grading Strawberries.—At the packing shed the berries may or may not be graded. If the crop is especially good, or if the market is not very critical, it may not pay to grade, or, at least, to do more than take out the very poor berries. But with a critical market, or with berries that run quite variable, it will

FIG. 74.—Culling pan for grading strawberries. Dimensions 4 inches wide at mouth; 8 inches at the other end; 12 inches long; 1½ inches deep.

always pay to sort them into at least two grades, and sometimes into three, No. 1, No. 2, and culls.

For this grading a sorting table should be provided on which the berries may be turned out to grade them. A plain box table with a bottom made by stretching cheesecloth over the frame will be found very satisfactory.

Another device which will aid materially in the work of grading is what is known as a culling- or grading-pan (Fig. 74). This is a metal or light wood box, open at one end, which is narrower than the other end. It is about twelve inches long, with the open end four inches wide and the other about eight inches, with sides an inch and a half high. The berries are

poured into this pan and the poorer ones picked out, while the good ones are allowed to pass through the open end and drop into a strawberry box.

Filling up the Boxes.—Great care should be taken to see that the boxes are full. Nothing hurts trade like scant measure. The box should be shaken a little to settle the berries into place, and for most markets, especially good ones, it should be faced on top. Just what this facing process consists of depends on the berries. If they are large, with handsome, fresh, green

FIG. 75.—A box of large strawberries faced to show the hulls. With berries of this kind (large and with attractive hulls) this kind of facing is probably the best. Compare with figures 76, 77, 78.

FIG. 76.—Same box of large strawberries as shown in figure 75, but faced with hulls down. Probably not so good as shown in figure 75. Compare also with figures 77 and 78.

hulls, then the box will be most attractive to the average customer if the hulls show (Fig. 75). On the other hand, with medium or small berries, or where the hulls are not attractive (either shriveled somewhat or small and poor-colored) the box will be more attractive if the hulls are turned down (Figs. 76, 77 and 78).

It goes without saying that the berries on top should not be any better than the average in the box. It is fatal to overlook this rule.

Crates.—Strawberries are usually marketed in crates of various sizes and shapes, but principally in the twenty-four and thirty-two-quart sizes (Fig. 79). Larger sizes are so heavy that

FIG. 77.—A box of small strawberries faced with hulls showing. Not attractive because the hulls are poor. Compare with figures 75, 76 and 78.

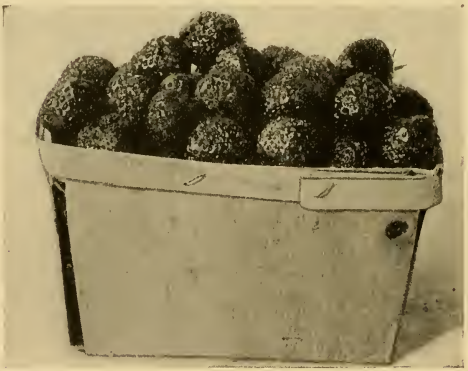

FIG. 78.—Same box of strawberries as shown in figure 77, but faced with hulls down. A better method with small berries. Compare with figures 75 and 76.

the expressman is apt to feel justified in handling them more roughly (which is quite unnecessary), and smaller sizes are not so economical, yet crates up to forty-eight and sixty-four quarts

are often used, especially in shipping longer distances, and crates as small as twenty-four pints are also sometimes used.

A tray holding a single layer of boxes is sometimes used, and for nearby and good markets is an excellent package. The one shown in figure 21 is made to hold twenty quart boxes and is painted green, thus setting off the berries nicely. It is, of

FIG. 79.—A 32-quart crate of strawberries. This is one of the popular sizes of crates as it is large enough to be economical and not so large as to be too heavy to handle carefully.

course, used only in a local market so that the trays are returned to the grower. A few such crates make a fine display in a dealer's window.

Labels.—For a strictly fancy trade some attractive label such as is used by the apple man is well worth using on the strawberry crates. This would necessitate a crate with a solid end on which the label could be pasted.

Refrigeration.—For longer distances strawberries are often

packed in what are known as "pony refrigerators." These are strong chests holding usually sixty-four or eighty quarts, and are arranged so that a tray of ice is placed in the top of the refrigerator, the berries being cooled as much as possible before they are put into the refrigerators. For small shipments of berries which must be shipped long distances and which will bring high prices, these refrigerators are very satisfactory. Larger quantities are shipped in refrigerated cars.

Marketing Promptly.—Strawberries should be taken to market just as soon as possible after they are picked and packed. The grower who can be sure that his berries are eaten the same day they are picked will avoid many of the troubles into which his less fortunate competitors fall, and will be correspondingly popular with his patrons.

QUESTIONS

1. What types of pickers are best for strawberries and why?
2. What does it cost to pick strawberries?
3. How would you insure that good picking would be done?
4. What is the best way of keeping the records of pickers?
5. What is the proper degree of ripeness at which strawberries should be picked?
6. Give a set of rules to govern pickers in their work.
7. What types of boxes and crates are used for strawberries in your section? Do you think these are the best?
8. Describe a good packing shed.
9. How frequently ought a strawberry bed to be picked over?
10. Discuss the grading of strawberries.
11. Describe the strawberry tray which is used instead of the crate. Do you think it is better than a crate?
12. Have you ever seen labels used on strawberry crates? Describe a good one.
13. What sizes of crates have you seen used either in field or market?
14. Tell what you can of shipping berries with refrigeration or without.

RASPBERRIES AND BLACKBERRIES

CHAPTER XVII

SITES, SOILS AND THEIR PREPARATION FOR RASPBERRIES AND BLACKBERRIES

There are about three factors which ought to be considered in the choice of a site for a plantation of any of the brambles. These are, in the order of their importance, soils, atmospheric drainage, and exposure or slope.

Soils are the all-important factor, because, while all these fruits will succeed over a fairly wide range of soil types, yet they all, with the possible exception of the dewberry, are very dependent on an abundant and continuous water supply, and this in turn is influenced by the soil type and soil conditions.

If one may classify these plants as to soil preferences, it might perhaps be said that the dewberry thrives on the lightest soils of any of them, while the black raspberry prefers the heaviest types, with the red raspberry and the blackberry intermediate. Roughly speaking, one should choose a sandy loam for dewberries, and it may be a light sandy loam at that; a heavy sandy loam, a silty loam, or a light clay loam (preferably the latter) for blackberries and red raspberries; and a clay loam from light to fairly heavy for black raspberries.

The one imperative point, as just suggested, is that the moisture supply be kept up, and a grower might select a fairly light loam and by keeping it abundantly supplied with humus, and by giving it very thorough preparation and cultivation to conserve his moisture supply, he might have even better success with black raspberries than another grower who had the ideal soil, a clay loam, but did not give much attention to these other matters.

In all cases the subsoil should be deep and retentive of moisture, which means that it should have considerable clay in its makeup. Nothing lighter than a very heavy sandy loam subsoil should be chosen unless one is forced to do so, and some of the silty or the clay loams are much to be preferred.

It ought also to be said that there is a fairly wide range in soil preferences among the varieties of raspberries or of blackberries, which should be studied by the commercial grower and met if possible. While the Cuthbert raspberry, for example, will succeed on a great variety of soils, the Ranere prefers a more sandy type and the June a clay type.

Atmospheric Drainage.—The second factor in the choice of a site for the plantation is atmospheric drainage. This is principally important for its effect on winter cold, since these fruits blossom so late that they are not very likely to be caught by spring frosts, and, of course, are harvested and out of the way before any possibility of autumn frosts, at least, in any section where they should be grown commercially. But one of the serious dangers with the grower who is located in any of the more northern sections is winter injury of the canes, and this may be influenced considerably by locating the plantation where the cold air will drain away onto lower lands.

Exposure.—Lastly, we have the question of slope or exposure, and in practically all cases a northern or northeastern exposure is to be preferred if it can be secured along with the other desirable factors. If any of them are to be sacrificed this one should be the first to go.

The advantages of the northern slope are that because the sun beats down on it less severely there is less drying out of the soil, and a somewhat cooler temperature of the atmosphere for the plantation. And both of these are very desirable, though not essential to the success of the plantation.

One other factor in the question of site is worth considering in some sections, and that is the one of prevailing winds. If these are likely to be strong during the growing season or during the severest winter weather, then it is quite desirable that the plantation be protected from them either by choosing land which slopes away from them or by belts of timber. The summer winds dry out the soil badly, the evaporation varying directly as the movement of the air over the surface, and the winter winds evaporate moisture from the canes, thus rendering them more subject to winter killing.

The Location.—The foregoing are all important practical points which ought to be considered in the locating of any plantation of these fruits and especially of commercial plantations. As a matter of fact, however, it is seldom possible to satisfy all of these requirements very fully, even with commercial plantations, and almost never with the home plots. Other considerations usually come in to decide the matter, particularly the question of convenience to the buildings on the farm, so that one or more of them has to be sacrificed.

Preparation of Soil.—In the matter of getting the soil ready for a plantation of raspberries or blackberries, two items stand out above all others. These are, first, very thorough and especially very deep preparation, and second, the incorporation of every available particle of humus that can be secured. Both of these go back, of course, to the need already suggested for a liberal and constant supply of soil moisture, and both are rendered the more serious because these plantations, when once established, are usually held for from five to ten years, during which time neither the fitting of the land nor the incorporation of humus can be carried on very satisfactorily.

Plowing.—In the preparation of the soil, plowing is first in importance and first in time. It ought to be as deep as it conveniently can be. If the soil is of the right type, ten inches are none too deep, and it never ought to be less than eight inches. If the soil will not stand an eight-inch furrow it should be used for some other crop. Moreover, in this plowing one should use a plow with a steep moldboard that will thoroughly break up the furrow slice as it is inverted. A good share of soil that is turned over by the plow will not be affected in the least by any of the other implements that follow in the process of fitting, if we except some pressure, which is, of course, exerted by every implement that goes over the plantation, and which serves to compact somewhat this lower soil. The disk harrow penetrates the deepest of any of them, and if one gets down five inches with any of the ordinary disks that are used to follow the plow, it is all that can be expected; four inches are much more common. Since we all recognize the importance of a thorough pulverizing

of the soil, no argument ought to be necessary as to this point of breaking up the furrow slice and therefore as to the type of plow to use. And yet men continue to judge good plowing by the beauty and straightness and compactness of the furrows.

With the plowing properly done, the other operations follow in regular and orthodox order with only this suggestion that each one of them be intensified as much as possible, realizing that this may be the last chance for ten years to reach some of the soil that will be moved.

Adding Humus.—As to increasing the humus content, no special discussion may be necessary. It is almost impossible to overdo the matter. Sod land plowed under for the crop preceding the berry plantation is an excellent beginning. Barnyard manure in liberal quantities is very desirable. If the scheme of preparation can be so arranged that one or more crops of some rank-growing plant, like buckwheat or barley, can be plowed in, so much the better.

QUESTIONS

1. Are blackberries and raspberries grown in your section? If so, on what types of soil do they succeed best?
2. What do you consider the ideal soil for raspberries? For blackberries?
3. How would you insure a plentiful supply of soil moisture for these fruits?
4. Is atmospheric drainage important with these fruits? Why?
5. On what exposure or slope would you prefer to set a blackberry plantation?
6. How would you prepare the soil for a plantation of raspberries or blackberries?

CHAPTER XVIII

ESTABLISHING RASPBERRY AND BLACKBERRY PLANTATIONS

Although neither the commercial grower nor the amateur is likely to propagate his own blackberry or raspberry plants, it seems worth while to give here a brief discussion of the question; and in order that we may get at it most intelligently some preliminary discussion of the botany of the brambles is necessary.

They are all derived from various species of the genus *Rubus,* and most of them (practically all that are of any importance in this country) have been developed from our wild American raspberries and blackberries. Indeed, this group of fruits is one of the most important contributions that America has made to our list of food plants. The botanical grouping of these wild species has been frequently changed in the past and no doubt will be again in the future. The U. S. Department of Agriculture is just now doing more work on the origin of these cultivated forms of *Rubus,* and this may and probably will result in changing some of the statements given here.

Blackberries.—We have, first of all, the blackberries which come principally from three species, *Rubus argutus, R. floridus,* and *R. frondosus.* But the wild species are very variable and blend into one another, so that it is impossible, and for present purposes unnecessary, to determine from which species or combination of species a particular variety has been derived.

These wild species differ in many minor points, such as blossoms (Fig. 80), the type of canes, the character and number of the thorns, and hairs, etc., which are botanical rather than horticultural questions and need not be discussed here. Almost any of them have all the thorns that are really necessary. The leading varieties of this group are Snyder, Eldorado, Taylor, Ward, Erie, Mercereau, and Ancient Briton.

Dewberries.—Next we have the dewberries which, except for their trailing habit of growth, are very similar to the black-

berries. These are mainly from three species, *Rubus procumbens, R. invisus,* and *R. Baileyanus,* with possibly some help from the southern dewberry *R. trivialis,* and the California dewberry, *R. vitifolius.* The last named is almost certainly related to the cultivated Loganberry, so important on the West coast, though just what the connection is has not yet been definitely settled.

The Lucretia and the Loganberry are by all odds the most prominent varieties in this group, the latter being grown almost altogether in the Pacific region, while the former is more popular in the East. Mayes is a successful variety for the middle section of the United States.

FIG. 80.—Types of blackberry blossoms.

Black raspberries are practically all cultivated forms of the wild species, *Rubus occidentalis,* and are very distinct, both in appearance and in methods of growth and propagation, from any of the others. Gregg, Kansas, Plum Farmer, Ohio, and Cumberland are leading and typical varieties.

Red Raspberries.—The red raspberries are derived from the wild red raspberry of America, *Rubus strigosus,* and from the European raspberry, *R. Idaeus,* all the important commercial varieties coming from the former. Cuthbert, King, Perfection, Antwerp, California, Surprise, Herbert, Ranere, June, and Marlboro are leading varieties of the American type. The Europeans are seldom grown in this country, never commercially.

The so-called Purple Cane raspberries are a very interesting group of varieties which are evidently of hybrid origin, having come from a crossing of the black raspberry, *Rubus occiden-*

talis, with the wild red raspberry, *R. strigosus.* They show variations in leaf and cane characteristics and in methods of propagation all the way from one of these species to the other. They have been placed in a group by themselves, botanically, with the designation of *Rubus neglectus.* Columbian, Schaffer's Colossal, and Royal Purple are leading varieties, the first being the most popular.

Propagation of Blackberries and Raspberries.—Turning now to the question of propagation we find that three entirely distinct and very interesting types of multiplication are in use in this group of fruits.

Suckers.—First, in the case of blackberries and red raspberries, we have the sucker method. It is the habit of these fruits, besides sending up the new canes from the crown of the plant, also to send up suckers or shoots some little distance away from the crown. These are connected with the parent plant by a strong underground stem which sends out more or less roots along its entire length. In this method of propagation the young sucker is severed from the parent plant with as many roots attached to it as can be secured, and is transferred direct to the new plantation, or may be grown for a year in the nursery row before setting permanently. This is an excellent way to get new plants for the home garden, either from plants already set on the premises or from nearby neighbors. There is only one objection to it and that is purely a matter of prejudice. Since the suckers from these two berries are usually the worst weeds with which the owner has to contend in his cultivation of the patch, many people have the notion that this tendency to sucker is intensified if the plants are propagated by the sucker methods, and are so strongly prejudiced against plants so grown that they will not take them if they can get any others. There is really no more danger of increasing this suckering tendency through propagating by suckers than there is of growing sheep without tails through the method of docking, but, of course, it is impossible to convince some people of this.

Root Cuttings.—A second method which is used more or less with all the brambles, though more particularly with the two

just mentioned, is by root cuttings. In this method roots of the desired variety are taken in the autumn and cut into short lengths, usually two and a half to three inches. Roots of the size of a lead pencil are preferred, though somewhat larger or smaller ones may be used. These cuttings are tied in bunches and stored in moist sand in a cool cellar where they will not freeze. While the cuttings have no buds on them when made, they develop adventitious buds during the winter, so that when planted out in the spring each cutting will usually have from one to three or even more of these buds. The cuttings should be planted in early spring in a shallow furrow two or three inches deep and grown here till the following autumn or spring when they will be ready to set and will usually have better roots than the sucker plants. The principal objection to the method is that in order to secure any great number of plants it is necessary to dig up and destroy the old plantation, and one may not care to do this. If the method is to be used systematically it is necessary to plan ahead for it and have plantations coming along which can be dismantled for the purpose.

Tip Layering.—The third method of propagation is found among Loganberries, dewberries, the black raspberries, and some of the purple canes. It consists in rooting the tips of the growing canes which are then transferred to the new plantation. Many of the tips will root without any assistance if the soil conditions are good, but the percentage can be greatly increased by either burying the tip or merely putting a small stone or a clod of earth upon it to hold it in place while the rooting process is going on (Fig. 81).

The Plantation.—In laying off the plantation the first question to be decided is the matter of distances between plants, and on this point there is rather a wide variation of opinions and practices. To begin with, it depends on the method of planting to be adopted, *viz.,* whether the plants are to be grown in hills, so that the plantation may be cultivated in both directions; and if not, whether only the plants originally set will be allowed to grow and bear fruit, giving us what is sometimes known as the "linear" system, or whether additional sucker plants will be

allowed to develop in the row, making it much thicker than originally set, and forming what is known as the "hedge" system. Besides the differences in distances dependent on the system used, there are also considerable variations due to the type of plant, whether blackberry, red raspberry, or black rasp-

FIG. 81.—Black raspberry plant after growth has started, showing part of the old parent cane at the left and the two new canes starting from the crown at the right.

berry; and occasionally differences are made due to the variety, a strong-growing one requiring more room than a weaker one.

With all these factors bearing on the question it will be seen that no very exact distances can be given, but the following are some of the ones in common use:

For the hill system, five by five feet is the most common distance. Hills are seldom grown closer together than this even for the smaller-growing raspberries, and, on the other hand, this

distance is often used for fairly strong-growing raspberries and even for blackberries. From this minimum distance we find the space allowed per hill gradually increased in different sections, and with stronger growing varieties, until we reach seven or eight feet each way for hills in many sections where the growth is strong and the need is recognized of an abundance of room for the best development of the plants and the most convenient handling of them. In particular it is imperative to adopt this

FIG. 82.—A young block of red raspberries set by the hill system and started for the stake method of training, after cultivation has stopped.

maximum distance if two-horse implements are to be used in cultivation as is the practice in some sections.

The two strong arguments in favor of the hill system (Fig. 82) are that cross-cultivation can be practiced, thus reducing the expense of keeping the plantation in good condition, and that the picking of the fruit is made very decidedly easier.

Linear and Hedge Systems.—With either the linear or hedge systems, the distance between the rows will vary from six feet with the red raspberries or occasionally with the black-caps where the growth is not very strong, up to eight feet where the need of more room is recognized. In the writer's opinion, it is doubtful whether it pays to put them closer than seven feet.

The extra cost of the additional space will be more than made up by better growth and ease in working the plantation.

The distance apart for the plants with these two systems, the linear and the hedge, will vary from two feet as a minimum, and this distance used with the red raspberries and a few of the more upright of the purple canes, to five or even six feet where the greatest amount of room is desired. Probably three feet would be the distance most commonly used.

The choice of distances must depend on a number of things, particularly the following:

1. Kind of soil, whether mellow and fertile, so that a strong growth will result, or rather poor, so that the growth will be moderate.

2. The class of fruit (blackberry or raspberry), and the variety, whether a strong or a weak grower.

3. The climate, particularly whether the air is moist, so as to encourage diseases, or dry, so that they are held in check.

4. The kind of culture to be employed, whether by hand or by horse labor, and if the latter, whether single or double teams and implements are to be used.

Disadvantages of Crowding.—But in any case, as already suggested, extra space is very desirable and ought to be carefully considered by the prospective planter. The following are some of the most important disadvantages which are likely to result from crowding:

1. There is more trouble from diseases due to lack of light and poorer air drainage.

2. The canes make a weaker and less satisfactory growth and consequently the yield is less.

3. There is considerable increase in the cost of establishing the plantation, particularly in the matter of plants and trellis, without a corresponding increase in yields.

4. The training of the plants cannot be done as easily nor as well.

5. Tillage operations are much more difficult, and the final result is not as satisfactory even after more time and expense have been put on the job.

6. Picking operations are more difficult. The pickers get about less easily and the picking is not likely to be done as thoroughly.

7. The crowding of the canes provides ideal places for the increase of insect pests.

8. Not only are yields smaller, but the individual fruits are smaller and consequently do not command as good a price.

Marking Off.—Having settled on the distances for the rows and the plants in the rows, the plantation is next marked off for setting. Several types of markers are in use, but probably the one shown in figure 38 is as good as any. In some sections a horse-drawn marker is used, of the type common in corn planting. In the hill system it is, of course, necessary to mark both ways; and even in the other two it has distinct advantages, one of them being that for the first season, at least, it is possible to cultivate in both directions, and another that the plants are spaced more evenly.

The best time for setting these fruits is, all things considered, in the very early spring. Next to this would come the late autumn, after growth had entirely ceased. If the former time is to be chosen the land ought to be plowed in the autumn if possible, so that it may be fitted just as quickly as may be after the season opens in the spring. If fall planting is selected then work should be deferred as late as possible and still get the plantation set before the ground freezes. Occasionally one finds a grower who sets out his plantation during September with the idea that the plants will make some growth and become established before cold weather. Some very satisfactory results have been secured by this method, but the later autumn date is more common. Plants set in the autumn will come through in much better shape if they can be given some slight protection such as a thin layer of straw or strawy manure.

Pruning Back.—Before the plants are set, or immediately thereafter, they should be pruned back to six inches or less of the old cane (Fig. 83). Since this cane is of no particular value except to mark the spot where the plant is set, and since it may even be a detriment to the plant if left so long that it sends out

fruiting shoots, and thereby exhausts the strength of the plant, it is best to cut it back more rather than less, and many growers make a practice of cutting it off altogether.

Setting Plants.—Various methods are in vogue for setting of the plants, but the following three are perhaps as common as any:

1. The field is laid off one way with a marker, establishing the distances for the plants in the rows. Then the rows are laid off by running furrows with a plow and plants are set at the intersections of the furrow and the cross marks, using a spade or shovel for whatever additional digging may be required.

FIG. 83.—Rooted tip of a black raspberry in good condition for planting out. Plenty of fibrous roots. The old cane should be cut back somewhat at setting.

2. A second method is to mark the field both ways and then dig the holes with a round-pointed shovel and set the plants as one would set apple trees.

3. A third method is to mark both ways and then set with a spade, inserting the spade at the point where the plant is to stand, then pushing it forward to open up a hole, inserting the plant behind the spade, withdrawing the spade and tramping the soil about the plant. In any case, the soil should be firmly pressed about the plants.

Each of the above methods (and many modifications of them) has its advocates, and all of them will give good results.

In the first and second methods the plants are dropped ahead of the setters, but not far enough ahead so that there is danger of their drying out.

In all cases the plants should be set somewhat deeper than they were before taking up. The black raspberries and the purple canes are set the shallowest, usually not over an inch deeper than before, while the red raspberries and the blackberries are often set as much as six inches deeper.

QUESTIONS

1. From what wild species are our cultivated blackberries derived?
2. Our cultivated dewberries?
3. From what species do cultivated red raspberries come?
4. What are the purple cane raspberries?
5. Describe the propagation of raspberries and blackberries by suckers.
6. Do you know of other plants that are propagated in this way?
7. Describe the propagation of raspberries and blackberries by root cuttings.
8. How can you tell whether any plant will propagate by root cuttings?
9. Describe the method of propagation used with black raspberries.
10. What are the best distances for setting blackberries? For raspberries?
11. Discuss the hill system.
12. What are the disadvantages of crowding the plants in a raspberry or blackberry plantation?
13. How would you mark off the plantation?
14. What is the best time for setting raspberries and blackberries?
15. How would you prune raspberry and blackberry plants at setting?
16. Describe the setting of the plantation of brambles.

CHAPTER XIX

CULTURE AND FERTILIZING OF RASPBERRIES AND BLACKBERRIES

After the plantation is once established its future care may be grouped under about seven heads, as follows:

1. Plowing.
2. Cultivating.
3. Hoeing.
4. Cover crops.
5. Intercrops.
6. Fertilizing.
7. Pruning.

A separate chapter is devoted to the consideration of pruning. We may now turn to a discussion of the other six in the order mentioned.

1. **Plowing.**—This ought to be done either in the late fall or the very early spring. If done in the autumn the furrows should be turned towards the rows, since this protects the plants better from winter injury by covering the base of them with a layer of friable soil which acts more or less as a mulch. If the plowing is done in the spring the furrows may be thrown either towards or away from the rows. There are advantages from either method. The plowing towards the rows will better cover in and smother any weeds that may be growing among the canes and it makes a little more finished job. Plowing away from the rows is somewhat better in limiting the width of the row (which is an important function of plowing), and if heavy hoes are used soon after, the strip left unplowed can be brought into good condition. Probably an alternation is best, one year toward the rows and the next away from them. Where plowing is done in the spring it should be just as early as the soil will work well, principally because later plowing allows the weeds to get a start. Moreover, if it is deferred until growth has started somewhat it cuts off and destroys a lot of the new feeding roots which have just started, thus compelling the plant to do this work all over again; and lastly in later plowing the team

and plow are likely to rub off a lot of the young shoots which are just starting out on the canes.

The plow should be run at a medium depth. Too deep will cut the roots unnecessarily, thus aggravating the tendency of the plants to throw up suckers (a tendency which is pronounced enough at best), while too shallow plowing does not cover well enough the material which may be on the surface of the soil (last year's cover crop and weeds) and does not prepare a sufficiently deep reservoir for soil moisture. The ideal depth is probably four or five inches.

2. **Cultivation.**—This should be thorough, but as shallow as may be and still keep the weeds and suckers down. It is peculiarly important that this should start early in the season in order to keep ahead of the grass, suckers and weeds in the rows. If they once get a good start it adds tremendously to the cost of getting the plantation into good shape again, more so than with many fruits, because there are so many canes to interfere with the work.

After the plowing has been finished, as shown in figure 84, the grape-hoe, or a heavy-toothed cultivator, such as is shown in figure 9, may be run along close to the rows to work up the remaining soil not turned over by the plow.

For the later cultivations this same type of cultivator will have to be used for the most part on account of the suckers. Frequently it will be found desirable to have some special shovels or teeth with square ends for use in these plantations. These can replace the ordinary sharp-pointed shovels and will cut off nearly all of the suckers, as well as weeds, while the ordinary type will dodge a good many of them. If a time comes in the season when the plantation is clean enough so that the lighter, spike-toothed cultivator (Fig. 10) may be substituted for the heavy one this ought always be done, for it should be remembered that the less the roots can be cut the fewer suckers there will be, and, of course, the latter type of cultivator will cut very few roots which are large enough to start suckers.

Cultivation ought to be especially thorough as the fruit nears the ripening stage, for then it is particularly desirable to keep

up the moisture supply. When picking starts it is often customary to run the small-toothed cultivator through the plantation after every picking to loosen up the soil which the pickers have trampled down. The objection to this is that it makes it unpleasant for the pickers to get about the plantation, but this will be more than offset (from the standpoint of the owner, at least) by the moisture saved at a critical time.

There is no crop raised where thorough tillage is more im-

FIG. 84.—Young raspberry patch after plowing in the spring. The furrows have been plowed away from the rows.

portant than with raspberries and blackberries. A comparatively long-term crop, they render thorough preparation of the soil difficult; and then, ripening as they do in the very hottest and driest weather of the season, they call for the largest amount of water when this is most difficult to supply. More crops of these fruits are damaged by poor tillage than by all insects and diseases combined. Once a week over the plantation is none too often!

3. **Hoeing.**—With thorough and timely cultivation hoeing may be reduced very decidedly, but it will always be necessary

to do a certain amount of it if the plantation is to be kept in the best condition. Even where cross-cultivation is practiced there are sure to be more or less weeds in the hills. It is especially desirable to give one thorough hoeing early in the spring, shortly after the plowing and fitting of the land have been done. For this purpose rather heavy hoes ought to be used, and some growers even use a light grubbing hoe or mattock. An especial effort ought to be made at this time to clean out all grass and weeds among the canes or in the center of the hills. This may mean some hand pulling, but is a vital point if the plantation is to yield its best, and particularly if it is to be kept in the best condition, or even in reasonably good condition, for future years.

4. **Cover-crops.**—The three most important points in a cover-crop for plantations of these fruits are: First, it shall start quickly, since cultivation is usually prolonged rather late in these plantations and the time available for growth is therefore short; second, it shall not be injured by frost, for the same reason, *viz.,* that little time will usually elapse between the date of sowing the cover-crop and the date of the first frost; and third, it shall be a large-growing crop, because humus production is the most important function of cover-crops in raspberry and blackberry plantations. For most sections few crops will be found better than barley. Oats are often recommended and are all right, but do not, as a rule, leave the soil in quite such good condition. About two bushels of seed per acre of either should be sown. If frosts are likely to hold off long enough to admit of a reasonable growing season after sowing the crop, then buckwheat may be admirable; while vetch, cowpeas, and soybeans are used in some sections; and lastly, a good crop of large-growing weeds is excellent (Fig. 85).

5. **Intercrops.**—The use of these crops in plantations of raspberries and blackberries is usually restricted to the first year or at most to the first two years of the plantation, depending principally on the distance apart of the rows, and the rapidity with which the plants develop and occupy the land. After two years what space there may be between the rows is usually best devoted to the berries.

The principal points to observe, in the choice of intercrops are, first, to select crops that will do well on the type of soil in the plantation, and second, to choose those which will not overcrowd the berry plants. Cabbages and potatoes are two excellent crops for this purpose.

6. **Fertilizers.**—The use of fertilizers on plantations of any of the fruits is always a disputed question. Some growers have great faith in them and use them in large amounts; others do not

FIG. 85.—Block of red raspberries two years old. Stake method of training, with a cover crop of weeds.

use them at all; while still others, and these are the large majority of our growers, use them in moderate quantities.

The practice with the fruits under discussion is just as badly mixed as any of the others and perhaps more so, but, as a rule, and a fairly general one, fertilizers are used.

Barnyard manure is the most generally popular form of fertilizer, and naturally so, since it carries such a large amount of humus, the value of which with these fruits has been repeatedly urged. From eight to ten cords per acre is the common rate of application, though occasionally as much as twenty cords are used. The principal objection to using it too freely is that while

there is no danger of overdoing it from the humus standpoint, yet it is also strong in nitrogen, and too much of this will cause these fruits to run to canes and leaves at the expense of fruit, and sometimes to winter-kill badly. Unless the field is very uniform as to soil the application of manure may well be varied in different parts, putting more on the drier and less fertile sections, and less on those parts which are naturally better. When large-growing cover-crops are being successfully grown in the plantation, and particularly if the nitrogenous ones as vetches or

FIG. 86.—Hens and raspberries combine well if there are not too many of the former. The weeds are kept down and much valuable fertilizing material is furnished to the plantation.

soybeans are used, the amount of barnyard manure used may be materially reduced (Fig. 86).

The barnyard manure may be applied at any time from late autumn till early spring. Labor supply and general convenience of the farm equipment are apt to decide this, but, of course, it should not be applied while the plants are still active in the autumn, nor should it be used in the late spring, else its slow availability may lead to late growth the following autumn.

Commercial Fertilizers.—In addition to barnyard manure some commercial fertilizers are usually used (Fig. 87). These will vary greatly with the locality, the owner, and the season.

All of the kinds of fertilizers discussed in Chapter III will be found in use and frequently many others.

If a ready-mixed fertilizer is to be bought, one carrying about three per cent. of nitrogen, seven or eight per cent. of phosphoric acid, and nine or ten per cent. of potash will generally be found satisfactory, if applied at the rate of 500 to 800 pounds per acre.

Home-mixed Fertilizers.—In most cases, however, it is customary to buy the materials and mix them at home, and for

FIG. 87.—Commercial fertilizers used on blackberries at Puyallup, Washington.

this purpose nitrate of soda and tankage are the common forms of nitrogen used; acid phosphate, bone meal and slag for phosphoric acid, and either the muriate or the sulfate of potash. Experiments at the Massachusetts Station have seemed to show that there is, under their conditions, considerably less winter killing of the canes with the sulfate than with the muriate of potash. The time of application of these commercial fertilizers is not a vital matter except in the case of the nitrogen which ought to go on very shortly after growth starts in the spring. If applied too early there may be loss of material through drainage water, and if too late the growth of canes may be prolonged too late in the season and cause winter injury.

The following are some fertilizer formulas that are used by successful raspberry and blackberry growers, the amounts being per acre:

Formula No. 1:
100 lbs. nitrate of soda
200 lbs. tankage
200 lbs. acid phosphate
200 lbs. sulfate of potash

Formula No. 2:
5 tons barn manure
400 lbs. acid phosphate
300 lbs. high grade sulfate of potash

Formula No. 3:
100 lbs. nitrate of soda
300 lbs. acid phosphate
200 lbs. high grade sulfate of potash

If barnyard manure is being used, then all other nitrogen may be cut out and the other two elements considerably reduced, probably cut in half.

Whatever materials may be used for fertilizing a good deal of common sense ought to be used with them. One needs judgment not only as to materials to be included in the formula, but also as to amounts to be applied to different parts of the plantation.

Home Experiments with Fertilizers.—Probably in the long run the most sensible thing to do is to experiment a little at home and watch results. Certainly this is best if one is to stay in the business for any length of time and if the soil is sufficiently uniform so that results secured on one block may be considered applicable to another block.

The following plan of experiments is merely suggestive and other combinations might be used to advantage. Select a field with as uniform a soil as possible and one which is typical of the farm. Apply fertilizers as follows: (1) 10 tons barnyard manure per acre, (2) 5 tons manure, 400 pounds acid phosphate, 200 pounds sulfate of potash, (3) check plot, no fertilizer,

(4) 400 pounds acid phosphate; (5) 400 pounds acid phosphate, 200 pounds tankage, 100 pounds nitrate of soda, 200 pounds sulfate of potash; (6) check plot, no fertilizer; (7) 200 pounds sulfate of potash. If reasonably small plots are used, say 15 by 20 feet, the entire space required will not be great and much valuable information may be secured.

QUESTIONS

1. Describe the plowing of a raspberry or blackberry plantation.
2. What cultivation should be given to such a plantation?
3. What precautions would you take to keep down weeds and grass along the rows?
4. Discuss the cover crop question as applied to these crops.
5. Would you inter-crop a raspberry plantation? If so, what crops would you use?
6. What fertilizers would you use on the blackberry plantation?

CHAPTER XX

PRUNING AND TRAINING THE RASPBERRY AND BLACKBERRY

As with all other fruits, the pruning and training of the raspberry and blackberry are among the most interesting operations connected with growing them, because they give one a chance to do some studying and to exercise some judgment. Compared with other fruits these operations are, however, very simple, even more so than with the grape, because the different kinds of growths are so simple themselves and adhere so consistently to a few types.

Character of Growth.—We have, first of all, in any season, the tall, succulent new canes coming up from the crown of the plant and growing anywhere from three to eight or ten feet, or even more, in the season. These canes may or may not form side branches that season, depending somewhat on the species (whether they are blackberries or some species of raspberries), somewhat on the variety, somewhat on the culture, and more than all on whether they are headed back by the owner or are allowed to grow on unchecked (Fig. 88).

In the course of this first season, lateral buds will be formed, on the main shoot in case it does not branch, or on the main shoot and on the side branches if these latter appear. These buds are shown in figures 89 to 91.

The following spring leafy shoots start out from these buds. In the case of blackberries these shoots may produce three or four compound leaves and then terminate in a dense cluster of blossoms (Fig. 92), usually with no leaves at all interspersed among the blossoms. The fruit stage is shown in figure 93. Or the shoot may be longer and produce no blossoms whatever. Occasionally, also, a side bud on a fruiting shoot will get a start and develop into a strong leafy shoot.

In the case of raspberries the character of these second season shoots is somewhat different, being a much longer growth, with

often as many as eight or ten leaves on it. In all three types, the reds, the blacks, and the purple canes, this shoot is terminated by a rather dense cluster of blossoms. In addition, there will be found in the reds small clusters of blossoms in the axils of the leaves for some distance back from the tip (Fig. 94). In the blacks there are very few of these secondary blossom clusters (Fig. 95) and sometimes none at all; while the purple canes, as might be expected from their hybrid origin, are intermediate, having more of these small clusters than the blacks and less than the reds (Fig. 96).

FIG. 88.—Black raspberries headed back to produce branching canes.

From the practical point of view, however, the growth is substantially the same, the fruit being borne on the current season's shoots which start from buds on last year's wood. After the fruit has ripened these old canes gradually die, so that by autumn they are quite brittle.

To recapitulate, then, the method of fruit-bearing with raspberries and blackberries is to grow a strong cane the first season from the lateral buds of which are sent out, the second season, short shoots which bear the fruit.

System of Pruning.—Turning now from the method of bearing to the systems or types of pruning, we find that this work may be grouped under three heads.

FIG. 89.—Types of blackberry canes. The two at the left are the best, the one at extreme right is altogether too weak.

FIG. 90.—Branched blackberry cane. This will send out bearing shoots from the lateral branches, but not from the main branch.

FIG. 91.—Raspberry canes showing types of development. The one at the extreme left is the best, the others being rather weak.

FIG. 92.—Bearing shoot of blackberry showing terminal cluster of blossoms.

FIG. 93.—Fruiting shoot of the blackberry shortly after blossoming, showing fruit development at end of shoot.

FIG. 94.—Fruiting branch of red raspberry. Fruit distributed along nearly entire length of shoot. Compare with figures 95 and 96.

FIG. 95.—Fruiting branch of the black raspberry showing distribution of fruit at end of shoot. Compare with figures 94 and 96.

FIG. 96.—Fruiting branch of purple-cane raspberry, showing type of fruit distribution intermediate between the black and red varieties. See figures 94 and 95.

Heading Back Young Canes.—The first season the young cane may be allowed to continue its growth unchecked or it may be headed back. The object of this heading back, if it is practiced, is to force the cane to send out side shoots instead of making one long central leader (Figs. 88, 90, 97 and 98).

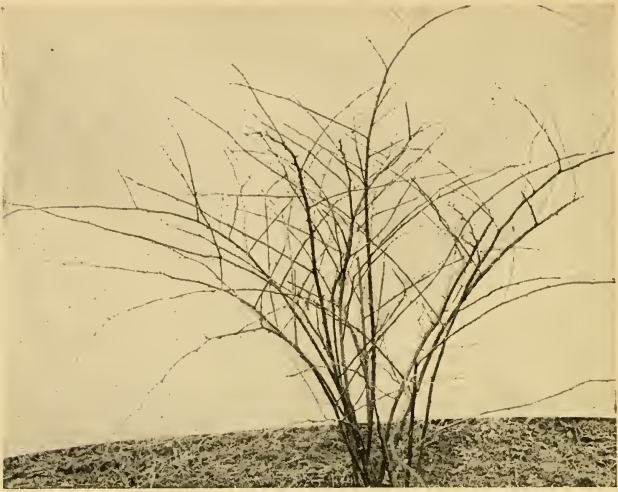

FIG. 97.—A hill of blackberries before pruning, grown without any trellis. Compare with figure 98.

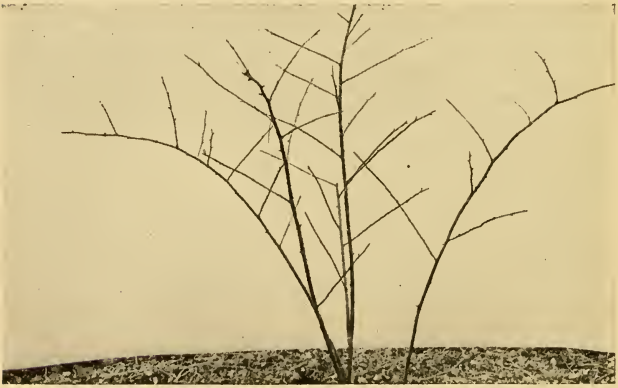

FIG. 98.—Same hill of blackberries as shown in figure 97, after pruning.

In blackberries and blackcap raspberries, the young canes are usually headed back in this way, while in red raspberries they are usually allowed to grow unchecked. The reason for this difference in practice is this. If red raspberries are headed in this first season, the tendency is for the canes to send out rather weak side branches and at the same time a lot of small weak canes that would not otherwise have started are forced out from the crown of the plant. The net result is that instead of having one strong, well-ripened cane, with vigorous side buds on it, we get rather weak side shoots and new and weak canes, all carrying weak buds for next year's fruiting wood. It will be found, then, that with most successful growers, whether commercial or amateur, the custom is to let red raspberry canes alone this first season. The principal exception would be in the case of very vigorous varieties, as Herbert, which are sometimes headed in. Being vigorous they make a strong growth of lateral branches which mature good strong buds for the next season's fruiting wood.

With blackberries and black raspberries, on the other hand, the effect of heading back is different. They are usually more vigorous in growth, and at all events respond differently to the stimulus of heading in, making strong laterals, frequently four or five feet in length, and *not* tending to send up the many additional weak canes as the reds do (Fig. 88).

When to Head Back Young Canes.—The one imperative point to be observed in this heading in of the young growing cane is to do it at the right time, and that is very shortly after the cane reaches the desired height. From eighteen inches to two feet is the usual height, though with some varieties, particularly in the West, this height is often increased to three or four feet. The tendency among growers is to head blackberries slightly higher than black raspberries. If the desired height is eighteen inches, the cane ought not to be allowed to grow more than two feet at the outside before it is headed back. When headed properly in this way it at once sends out strong side shoots, while if the new cane is allowed to make, say, three or four feet, and then is headed back to eighteen inches, a great

deal of time and energy have been lost and the side shoots start more slowly and never make as satisfactory a growth.

Moreover, the work of heading back can be done much more easily and quickly when only the soft growing tip is to be removed than it can when the point to be severed has become more or less hard and woody. The thumb and finger may be used for this pinching back, but some sort of shear is generally to be preferred, one which is light and works easily being best. It will generally be found best to go over the plantation several times as the new canes reach the desired height.

Spring Pruning.—The second and principal type of pruning is done before growth starts the second spring. It consists in taking out altogether the weak canes and (in the case of blackberries and black raspberries) in shortening back the lateral branches on the canes that are saved. To decide just how much these laterals shall be shortened calls for considerable experience and judgment, but the usual practice is to leave them about twelve to eighteen inches. Some varieties tend to bear fruit on the side branches nearer to the main cane than others do. If the latter varieties are headed in very closely we may therefore remove most, or all, of the buds which would produce fruiting shoots and save only the leafy shoots. Moreover, since in heading back these side shoots we are always regulating the size of our crop, we must, in order to do it intelligently, know how much fruit each variety can profitably bear under our own particular conditions. If the side shoots are cut back too much the crop may be unnecessarily reduced, and if they are left too long the present crop may be increased at the expense of future crops, because so much of the vigor of the parent plant is turned to fruit that there is not enough left for the best growth of new canes. On the average, however, we shall not miss it far if the laterals are left about fifteen inches in length; that will at least do for a trial, and the operator can study his varieties and his conditions and judge better with each year's experience.

Removing Canes After Harvest.—The third type of pruning is the removal of the old canes after they have borne fruit. This is done at any date from the time the last of the crop is

harvested in late summer up to the annual spring pruning, but it is the most common practice, and probably the best, to take them out as soon as possible after the crop is off (Fig. 99).

The arguments in favor of this practice are, first, the canes are softer then and cut much more easily than when they have become dry and woody; second, there are likely to be diseases and insects harbored in them which will be destroyed by their removal; and third, when they are out of the way the young canes have more room, get more light and air, and consequently

FIG. 99.—Types of long-handled pruning shears used in cutting out canes of raspberries and blackberries.

make a better growth and bear better the following year. There is also an opportunity to thin out the young canes at the same time to just the desired number. The weakest canes are, of course, removed, and this throws all the vigor of the plant into the few canes that are saved.

There are three arguments in favor of deferring their removal till later: First, that some little strength probably goes from these old canes back to the crown of the plant; second, that it is frequently not convenient to get the necessary labor then, while late in the autumn or early the next spring it may be easily done; and third, that they afford some support to the new canes during the following winter, when they might otherwise be

broken down by snow. None of these arguments seems very strong, however, unless the question of labor may be serious.

Systems of training vary from none at all to fairly complicated methods, and there are, of course, all sorts of minor variations, but the following are the principal types:

FIG. 100.—Stake method of training raspberries and blackberries, This has the advantage of allowing cross cultivation.

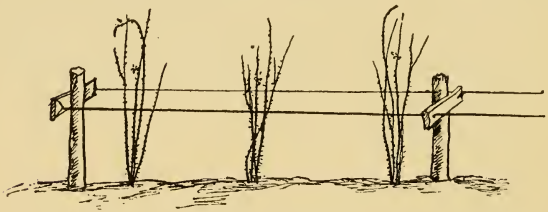

FIG. 101.—A good trellis for raspberries and blackberries—two wires on cross-pieces about 18 inches long.

1. **No trellis at all** is used, but the canes are topped back and forced to branch and become strong and stocky, so that even when loaded with fruit they do not bend over enough to get the fruit dirty. This method is fairly common with blackberries and with black raspberries, especially under soil and climatic conditions which do not tend to a very strong growth, but is seldom used with the red raspberries (Fig. 88).

2. **Tying the canes up to one or two stakes** or posts for each

hill (Figs. 82, 85 and 100) is a common method and is becoming more popular in many sections, its particular advantage being that it allows of cross-cultivation, eliminating, to a large extent, hand labor. Where two stakes are set, the fruiting canes are tied to one and the new canes to the other, thus simplifying very decidedly the operation of picking, and preventing injury to the new canes by the pickers.

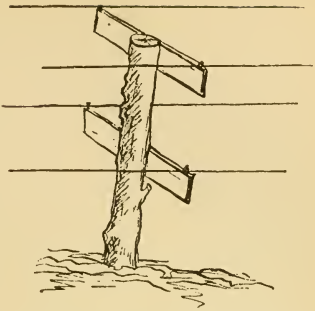

FIG. 102.—A modification of trellis shown in figure 101. The bearing canes may be bent over the wires on one side and the young growing canes kept on the other side.

3. **Two wires** are run along the row, one on either side, to support the canes and keep them out of the mud and out of the way of the cultivator (Fig. 101). The posts are set from fifteen to thirty feet apart, and of a height to suit the height of the canes, generally from three to four and one-half feet above the ground. A cross-piece about a foot and a half long is nailed to each post near the top and a No. 10 wire is run along each side and fastened to the ends of the cross-pieces. This, of course, allows the new and old canes to intermingle. A modification of the system is used in some sections by putting two wires on each side, the lower pair being two to two and one-half feet from the ground and the upper pair four

FIG. 103.—A modification of trellis shown in figure 101 with cross-pieces along wires. Hill system with 6 to 10 canes per hill. Puyallup, Wash.

and a half. The bearing canes are then bent over the upper wire on one side and tied to the lower wire, while the new canes grow up in the space between the wires, thus separating the two types of canes with the consequent advantages already suggested (Figs. 102 and 103).

4. **The Single Wire Method.**—A fourth method is to run a single No. 10 wire down the center of the row on posts from three to five feet high. To this wire the canes are tied (Fig. 104). Of course, this decreases the expense of the trellis considerably over the last method, by leaving out one wire and the cross-pieces, but it adds the expense of tying so that costs are not very different in the long run.

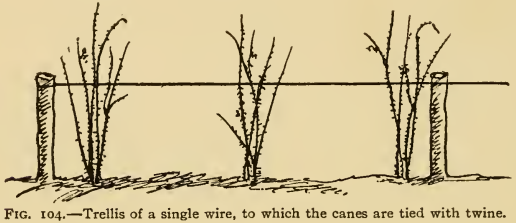

FIG. 104.—Trellis of a single wire, to which the canes are tied with twine.

In some sections of the state of Washington a new and very satisfactory method of handling long canes on a single wire has been developed. It consists of bending the canes over the top of the wire and then weaving them in among the canes of the next hill (Figs. 105 and 106).

5. **One Wire Above Another.**—A modification of this trellis consists in using longer posts, generally four to six feet, and putting on two wires about two feet apart, the upper one at or near the top of the posts (Fig. 107). In this case it is not necessary to use so heavy a wire for the lower one, since the most of the strain comes on the upper wire. A No. 12 wire will usually be sufficiently strong. The canes are tied to both wires, thus giving them better support but also increasing the cost.

A modification of the method of tying with this same trellis is shown in figures 108, 109 and 110, where the canes are bent

over the upper wire and brought down and tied to the lower wire.

6. **A Washington Plan.**—Stahl, of Washington, describes a system in use in the Puyallup district as follows:

FIG. 105.—Modification of system shown in figure 104. The canes are here bent over the wire and their ends woven in among the canes of the next hill.

FIG. 106.—Curling or snail method of training used by Japanese growers at Auburn, Washington. It is a modification of system shown in figure 105.

"A plan of training very much like the old French method has been tried by some growers and is being adopted in a number of newly set fields. The rows are set north and south, eight feet apart, and trellis placed about a foot to the east of each

row. The trellis is made by using 8-foot posts, ten inches to a foot in diameter. They are set three feet in the ground about fifty feet apart. Posts seven feet in length may be substituted, but they must be set closer. A wire is stretched from post to post, three feet from the ground, and on the side of the posts nearest the plants (Fig. 111). The bearing canes are drawn

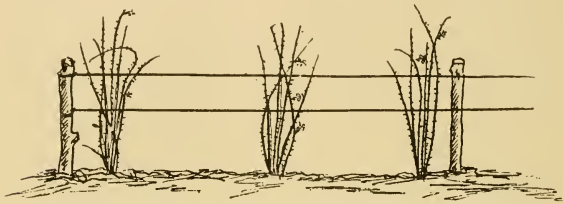

FIG. 107.—Modification of trellis in Fig. 104. Consists in using longer post, generally four to six feet and using two wires.

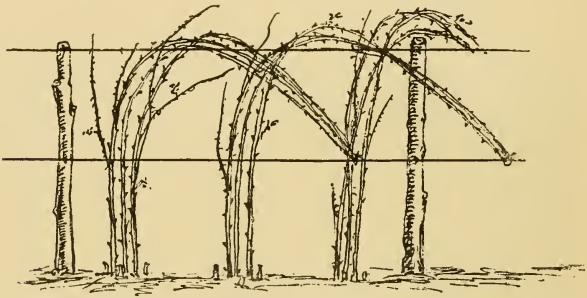

FIG. 108.—Modification of trellis and training in figure 107. Canes bent over upper wire and tied to lower. See also figures 109 and 110.

over to the wire and securely tied with string. On the opposite side of each post and ten or twelve inches higher another wire is stretched. The bearing canes hang over this wire but are not tied to it. As the fruit is developed the canes gradually droop until they rest on the upper wire. They are thus supported and can be easily pushed to one side without injury as the fruit is picked. All of the picking is done from the east side of the row and the new canes are not disturbed. The new

FIG. 109.—Modification of system shown in figure 108, the ends of the canes being woven in among the adjoining canes and not tied.

FIG. 110.—Another view of same system shown in figure 109.

or young canes grow erect and are held in place by stretching a temporary wire on the west side of them and a few inches below the lower wire of the trellis to which the bearing canes are tied. Stretching of the temporary wire may be done any time after the young canes are three or four feet in height and before

harvest. With this system of training the pickers are in the shade of the plants most of the day. Cultivating is made no harder than with other systems and the canes are given every opportunity for development."

7. **For trailing sorts,** which produce long recumbent canes, a trellis is used which consists of a single post five feet high with

FIG. 111.—Trellis of three wires which separates the bearing canes from the non-bearing. Shown here after the bearing canes have been removed.

two cross-arms (Figs. 112 and 113) on which are run four wires. The cross-arms are 18 inches or two feet long, and one is nailed at the top of the posts and the other about three feet from the ground. The young growing canes are trained along the two upper wires, while the two lower wires support the fruiting two-year-old canes; or the two lots of canes may be

FIG. 112.—Trellis and training for the trailing types of berries. The bearing canes are above and the young, growing canes below.

FIG. 113.—Another view of the same system shown in figure 112. Some growers reverse the arrangement shown here and put the young canes on the top wires and the bearing canes below.

reversed, the young canes going below and the fruiting canes above. In either case the fruiting canes are separated from the non-fruiting ones, which is always an advantage since the operation of picking is facilitated and the new canes are not injured by the pickers. Cross-pieces of wood with notches cut in their ends are used and the canes are trained along the wires horizontally by weaving them in and out among these cross-pieces.

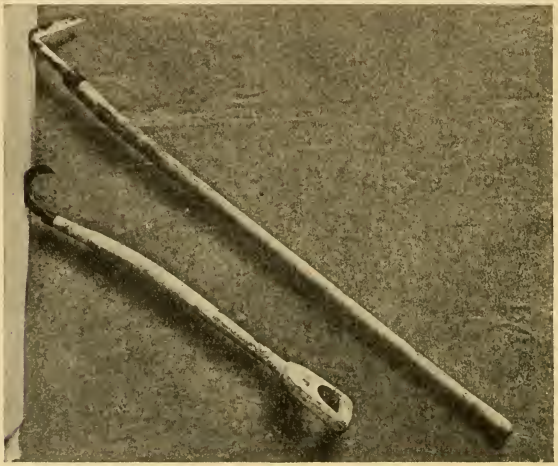

FIG. 114.—Two home-made hooks for removing old canes of raspberries and blackberries. Any good blacksmith can make the blades out of an old file.

The tools required for pruning raspberries and blackberries are few and simple. With blackberries in particular, but to a large extent with all these fruits, it is desirable to keep as far away from them as possible on account of their thorns, and long-handled implements are therefore chosen. Two types are especially common. One is the hook, shown in figure 114, which is used for removing the old canes after fruiting, and to a less extent the young canes which it is desired to thin out. It must be kept sharp if it is to be at all satisfactory, otherwise the

jerking necessary to cut off the old canes tends to disturb the roots of the plant.

The other implement is the long, two-handled shear, several types of which are shown in figure 99. It has the advantage over the hook that one does not disturb the roots any, but the work is apt to be done more slowly and with somewhat more danger of scratching to the operator. For the shortening in of the laterals a pair of the ordinary hand shears is generally used.

QUESTIONS

1. Describe the growth of a bearing red raspberry plant, following it through two seasons.
2. How would you prune a raspberry cane during the first season of its growth?
3. How would you prune it during the following season?
4. How should the canes be treated after they have borne?
5. Describe the stake method of training raspberries.
6. Describe the single wire methods.
7. What methods of training have you seen? Which of these do you like best?
8. How are the trailing varieties of these fruits trained?
9. What are the best tools for pruning raspberries and blackberries?

CHAPTER XXI

INSECTS AND DISEASES OF THE RASPBERRY AND BLACKBERRY

While there are plenty of pests for these fruits, and the grower ought constantly to be on the watch for them, and ought to plan the care of his plantation with a view to keeping them in check just as far as possible by cultural methods and general management, yet, as with the strawberry, there are no pests of the "first magnitude," take the country over.

This is not saying that in some localities and during some seasons there may not be very serious injury from the anthracnose or the crown borer, but it *is* saying that there is nothing to compare with the codling moth or the scab in apple orchards.

Among insects there are a dozen or fifteen that are likely to be more or less troublesome, but most of them are rather restricted in their range and not over four or five are worth including in this brief discussion.

1. **Cane-Borers.**—Probably the cane-borers are the most widely distributed of any of these pests. There are two types, the most common being a native American insect about half an inch long, with a black body and a yellowish neck or prothorax. It is one of the many long-horned borers. The eggs are deposited by the females in the pith of the young growing canes about six inches from the tip. At the same time she makes two rows of punctures around the cane about half an inch apart, one above, the other below, the spot where the egg is deposited. The object of these punctures is supposed to be to prevent the eggs from being crushed by the growing tissues, the injury checking the growth or stopping it altogether at the point where the egg is deposited. At all events it causes the tips of the canes to wilt, thus giving notice to the owner that the work is going on (Fig. 115).

Most of the eggs are deposited in June, though a few of the insects are at work nearly a month earlier and later than this date.

The larva requires two years for complete development. During the first season it bores only a short distance down the cane, living on the pith. During the second season it continues to work down the cane, which is now in its fruiting stage, and it usually prevents the fruit from maturing. It reaches the base of the cane by the second autumn and passes the winter there, and emerges in May or June to begin the cycle again.

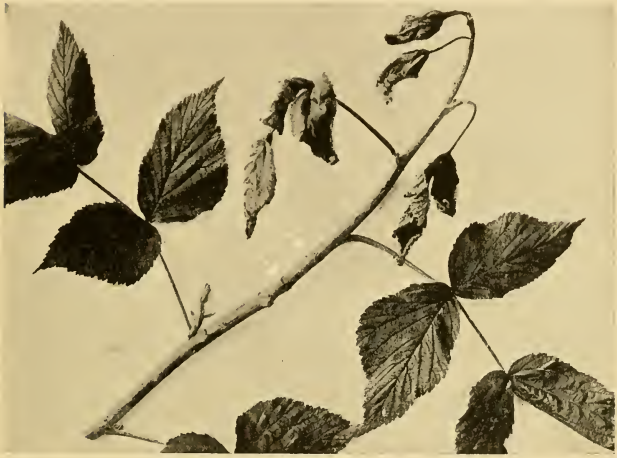

FIG. 115.—Work of the raspberry cane-borer. Note the two rows of punctures by the white arrows. The eggs are deposited in the section between these two rings of punctures.

The wilting of the cane tips is fairly conspicuous, and the remedy consists in cutting out and destroying these canes or the tips of them as soon as they are discovered. One argument for cutting out and burning the old canes as soon as the crop is harvested is the fact that by so doing this pest is pretty effectually kept in check.

2. **Crown-Borer.**—This is the larva of a clear-winged moth, something on the order of the adult insect of the peach-borer. The eggs are deposited on the leaves of the plants in August and September, and on hatching the little larva crawls down the

stem and passes the winter at the base of the cane. In the spring it burrows into the stem and spends the season feeding in the roots or in the stem near the crown of the plant. They pass the second winter in their burrows and the second summer continue feeding up to midsummer. By this time they have attained a length of nearly an inch and have done great damage to the plant. They enter the pupa stage in July, and the adult emerges in August or September and the eggs are again deposited.

The presence of these borers is indicated by the sickly appearance and eventually by the dying of the canes, and they are combated by digging out the larvæ, or by digging out and destroying the affected plant. Frequent shifting of the plantation is also helpful.

3. **Raspberry Sawfly.**—This insect is much more serious on the raspberry, but sometimes attacks the blackberry as well. The adult insect is a small, dark-colored, four-winged fly which deposits its eggs during May in incisions made in the under surface of the leaves. The eggs hatch in a few days. The larvæ are pale green in color and covered with spiny tubercles, the spines changing during the growth of the larva from whitish to brownish. They begin eating on the outer surface of the leaves, but eventually they eat away all the leaf tissues except the main ribs and occasionally attack even the bark of the young twigs. When they are full grown they are about three-quarters of an inch long, at which time they enter the ground about two or three inches and change to the pupa stage, emerging the following May.

Spraying with arsenate of lead during the early part of the attack is the best remedy. If this is neglected till the fruit has attained some size, it is best to use helebore at the rate of one ounce to one gallon of water, on account of the danger to persons eating the fruit.

4. **Red Spiders.**—These are not insects, but very minute mites, yellowish or reddish in color, that feed on the leaves of various plants, including the raspberry. They are not generally troublesome except in very dry seasons, since heavy rains tend to destroy them. They are found on the under surface of the leaves, but are so small as to be difficult to distinguish without a

magnifiying glass. They suck the juices of the leaves and must therefore be attacked with contact sprays. Finely-powdered sulfur at the rate of one pound to three gallons of water or nicotine sulfate at the rate of one-half pint to fifty gallons of water are the two most common sprays. The work must be done very carefully and thoroughly, as only those mites that are hit by the spray will be destroyed.

Anthracnose.—Among diseases the anthracnose is easily the most common and most serious. It is most virulent on black raspberries, next on blackberries, and least troublesome on red raspberries. It attacks both the canes and the leaves, but is much more conspicuous on the former, showing first as small brownish or purplish spots which are more or less depressed in the center and raised along the edges. These begin to appear on the young growing canes when they reach a height of about twelve inches. These spots gradually increase in size and often coalesce forming large patches, and in some cases entirely girdling the cane. At the same time they change color, becoming grayish in the center and much more conspicuous. The leaves or canes which are attacked are small in size, the leaves often with the edges rolled inward. The fruit is also dwarfed and ripens prematurely, or even dries up without ripening.

In very bad attacks the injury is so conspicuous as to be noticed at once, but in more mild attacks, which are more common, it may be present in a plantation for several years before its presence is noted.

Remedies for Anthracnose.—Several lines of attack are open to the owner.

1. All the old canes should be cut out, along with any very badly infested young canes, immediately after the fruit has been harvested. These should be burned as soon as they are dry enough, which will require only a short time.

2. Spraying has considerable value in holding the disease in check, but many authorities doubt whether it pays for its cost by the extra yield secured. If it is to be done the following program is best: *First,* spray with a plain solution of copper sulfate, one pound to 25 gallons of water, before the buds start.

Second, spray with Bordeaux mixture, 4-4-50 formula, when the young canes are about six or eight inches high. *Third,* spray again with Bordeaux after the old canes have been removed.

3. Give the plants plenty of room so that they may get the maximum amount of light and air. This would mean wider spacing of the rows and hills, and allowing fewer canes per hill or per foot of row.

4. Make frequent plantings on new land, shortening up the life of the old plantations proportionately.

5. Be very careful to select the best of stock which is free from the disease.

6. Give the plantation the best of care in cultivation, fertilizing, etc.

Orange Rust.—This is often a very serious disease on blackberries, somewhat less so on black raspberries, but is not usually very troublesome on red raspberries. The first indication of it is a peculiar yellowish green color to the leaves which assume an abnormal, somewhat elongated shape. Later on orange-red pimples appear on the under surface, which finally burst open, releasing the spores, which spread the disease to other plants. The spores germinate on the surface of the leaves and the root-like mycelium or vegetative part of the fungus spreads through them to the cane and eventually to the parts of the plant below the ground where it lives on from year to year and is a constant source of infection for all future growth from that particular plant, as well as spreading the disease to other plants. The only possible remedy for an infected plant is to dig it up and burn it, and this should be done as soon as the trouble is detected.

Cane Blight or Cane Wilt.—This disease attacks both the red and black raspberries about equally. It is most noticeable and does the most damage on the fruiting canes, but may often be found on the young canes during their first season's growth.

On the diseased canes the bark becomes lighter colored, with dark, discolored patches where the disease breaks out in the spore stage. These areas may be small or large; if large they may extend up and down the cane, or may encircle it. In the latter case that part of the cane above this girdle dies quickly, causing

the familiar wilting and drying up of the leaves and shoots (Fig. 116). The wood is also discolored and in time becomes very brittle.

This disease is disseminated largely through diseased nursery stock, but may be carried in many other ways, such as cultivation, which disseminates it through moving soil or detached branches; by men pruning in the plantation; by pickers and by

FIG. 116.—Raspberry cane blight or cane wilt.

rain or wind. Where there is a bad attack it often causes damage to the crop as high as 40 to 50 per cent.

The disease appears to gain entrance to the canes largely through openings in the bark, such as pruning wounds, broken stubs of branches, etc.

The disease may be combated in various ways, the principal remedy being to cut out and burn affected canes. Of course, the sooner this can be done after the cane becomes affected the better, but the presence of this disease in a plantation,

or the danger that it may get in, is an additional reason for cutting out and burning the fruiting canes as soon as the crop is harvested.

Preventive measures are much the same as outlined under anthracnose, *viz.*, set only healthy nursery stock, renew plantations frequently, and give the best of culture.

Crown Gall.—The roots and crowns of raspberries and blackberries are frequently attacked by a disease which produces galls or swellings similar to those sometimes found on the roots of apple trees. It is more destructive to raspberries than to blackberries and is considerably worse on the reds than the blacks.

It is too frequently spread by diseased nursery stock. In the plantation it is carried by cultivation and any other operation which moves soil from one part of the block to another. Plants affected by the disease have a sickly appearance and whole plantations are frequently killed.

The remedy is to dig out and destroy affected plants. The best preventive measures are to use healthy nursery stock. Inspect plants carefully before planting. Be careful not to set a new plantation on land which is affected with the disease. (See Chapter XIII, Nematodes.)

QUESTIONS

1. Describe the cane-borer of the raspberry. Did you ever see the work of this insect?
2. How does the crown-borer work? What would you do to control this insect?
3. Describe the habits and control of the raspberry saw-fly.
4. What are red spiders? How would you control them in a raspberry plantation?
5. Describe the anthracnose of raspberries and blackberries. How would you control it?
6. Did you ever see the orange rust on blackberries? Describe it, How would you control it?
7. Describe the cane blight or cane wilt.
8. What is the crown gall like? What do you understand by "a bacterial disease?"

CHAPTER XXII

HARVESTING AND MARKETING THE RASPBERRY AND BLACKBERRY

While in some respects these berries are more easily harvested and marketed than are strawberries, yet in several ways they are more difficult to handle. They are thorny and disagreeable to work among, the weather is apt to be hotter and more uncomfortable, and the need of good judgment on the part of the picker is considerably greater.

HARVESTING

The labor situation is much the same as with strawberries, with these additional difficulties:

1. **Degree of Maturity.**—It is much more difficult to establish a standard for the degree of ripeness and to see that the pickers live up to this standard. All of these fruits color some time before they are ripe. Blackberries in particular are black some days before they have developed the quality that they should have. Of course, the desirable or permissible degree of ripeness for picking will depend on the distance to market. If the fruit is to be shipped some distance, then eating quality must be sacrificed to carrying quality, and this simplifies the problem somewhat, since for the distant market they may be picked as soon as they are thoroughly black, a fairly easy rule to live up to. For the strictly local market blackberries may be allowed to get fully ripe on the vines which, as suggested, adds to the difficulty of picking; in fact, this is the most difficult market for which to pick satisfactorily, because the pickers are certain to pick some berries that are black but by no means ripe (Fig. 117).

With red raspberries it is somewhat less difficult to establish the right standard for ripeness, because the indications of the stage of maturity are more marked. When the berries take on a handsome attractive color, losing somewhat their glossy appearance, becoming softer, and separate more readily from the re-

ceptacle, they are ready for picking. If they are to go to distant markets the stage of ripeness is less and for local markets more. In any case, it ought to be borne in mind that even for the most local of markets they should not be allowed to become too ripe, since they lose quality rapidly after a certain stage of

FIG. 117.—Raspberry pickers of various ages. A mixed gang like this will usually do good work. Note type of carrier.

ripeness has been reached, whether they remain on the vines or not (Fig. 118).

Black raspberries are even more easily handled than reds so far as ripeness is concerned, since one has more latitude in the matter from the fact that they are firmer and not so perishable. When they separate readily from the receptacle they are ready for picking.

2. **Thorns.**—The second special difficulty in picking these fruits comes from the fact that they are so thorny. Blackberries in particular are vexatious to handle; but even the red rasp-

FIG. 118.—Picking raspberries, Puyallup, Washington. Note carrier with long legs which obviates bending by pickers.

FIG. 119.—Berry pickers' quarters, Puyallup, Washington. Growers furnish such quarters for pickers who stay through the season. Good water, clean quarters and a sanitary location do much to keep pickers happy.

berries, which are the mildest of the lot, are uncomfortable things to get very close to. This means that everything possible should be done to make the plantation convenient for picking.

Some method of training is almost imperative, and the more strictly the method can confine the canes the better. If the bearing and non-bearing canes can be separated (as is done in the double stake method and in some of the trellis methods) this will be a great assistance. Restricting the number of canes, both bearing and non-bearing, will also help to allow the pickers to go about their work more comfortably.

FIG. 120.—Red Antwerp raspberries, Sumner, Washington, which have produced 14,000 pounds of berries per acre in two successive years. It is a "man's job" to reach to the top of canes like these.

3. **Hot Weather.**—A third special difficulty in handling the picking question satisfactorily with these fruits is the fact that they ripen during the hottest weather, when the working conditions for the pickers are least comfortable. The heat, combined with the thorniness of the bushes, will discourage a good many of the pickers, particularly the younger ones.

Pickers Want to Quit.—Lastly we have the fact that these fruits are the last to be picked, blackberries being absolutely the rear guard, and a picker who started out enthusiastically on strawberries may decide when he gets to the blackberries that he has earned enough money, or that he would prefer to hoe corn, or work in his own garden, or even go fishing. It is, therefore, especially desirable to establish some bonus system for the pickers who stay right through the season.

When operations are on a fairly large scale or help has to be brought from a distance some regular quarters for the pickers will help greatly in getting the required help (Fig. 119).

Young Pickers.—With some methods of training, particularly the stake method, and with very tall canes, it is not always possible to employ quite such juvenile pickers with these berries as with strawberries, unless they are attended by older relatives

FIG. 121.—Block of Perfection red raspberries in full bearing trained in stake method. Taller than a man's head and loaded with fruit. Children would find it impossible to pick successfully in such a plantation as this.

who will pick on the same row and gather the berries from the tops of the canes (Figs. 117, 120 and 121).

Take Berries to Shade.—Great care should be taken to keep these berries, and particularly the blackberries, out of the sun after they have been picked. Exposure to hot sun for even a few minutes will cause them to turn reddish, detracting materially from their appearance and quality, and at the same time reducing the length of time that they will stand up in transit. If they cannot be taken at once to the packing shed (Figs. 122 and 123) they should at least be placed in the shade of a tree.

FIG. 122.—A convenient berry picking shed. Note crates stored at right.

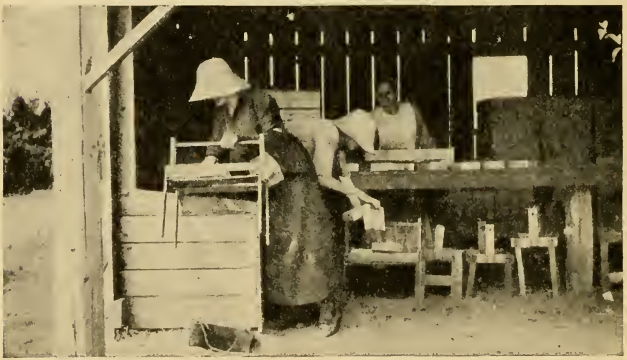

FIG. 123.—A good type of packing shed. Note type of carriers which girls are filling with empty boxes.

Avoid Picking Damp Berries.—The berries ought not to be picked while they are damp; this is especially important with red raspberries. In seasons of heavy dews it may be difficult to avoid having some moisture on them where picking is done in the cool of the morning, which is always a temptation at this

time of year, but it should be borne in mind that what is gained in the comfort of the pickers and in the coolness of the berries is more than lost in the greater danger that the fruit will not stand up well and that decay will start.

Careful Handling.—The berries ought to be handled very carefully, for although there is less danger from the rough handling of these fruits than with strawberries, yet with red raspberries and blackberries, especially if they are ripe, a good deal of damage may be done if they are thrown into the boxes instead of being placed in them carefully. Black raspberries, being firmer, will stand up better under adverse treatment, but even these are considerably damaged by rough handling. If the pickers are trained to use the thumb and two fingers in picking a berry, instead of the thumb and one finger, less pressure will be required to remove it from the receptacle and it will consequently be in better condition. It is also important that only a few berries be held in the hand at a time.

Frequent Picking.—The plantation should be picked over frequently. Usually every other day will be sufficient for any particular row, but with unusually warm weather it may be desirable to pick every day. The reds deteriorate more quickly than the blacks or blackberries, but none of them are improved by leaving on the bushes too long.

Clean picking of the bushes ought also to be insisted on. If there is considerable difference in the degree of ripeness of the fruit some grading may be done by the pickers, putting the ripest in one box and the firmer berries in another; then the ripe berries may be used locally for canning, while the firmer ones are shipped to market. Even if they are all shipped, the separation of the two degrees of ripeness is desirable. Any berries which, at picking time, are so ripe that they are a menace to the other berries should be picked and dropped on the ground. Never leave them on the bushes, as some of them are sure to get into later pickings.

The ripening period is considerably longer with the red raspberries than with any of the others. This is due to the longer blossoming period which might be expected from an ex-

amination of figures 93, 94, 95 and 96. This is a distinct advantage in the home plantation, since it lengthens the period during which the fruit may be had for the family table. For commercial plantations it is for the most part an objection, because it adds to the expense of picking, as it necessitates going over the plantation a greater number of times. Of course, if pickers are paid by the box the extra expense is on them instead of on the owner.

A Berry Harvester.—In sections where these berries are grown exclusively for drying, or in plantations where the last of the crop is used in this way, a harvester is often used for gathering the fruit. This is a light frame of wood about three feet square, covered with canvas. It is slid along the row and the operator carries a hook in one hand and a paddle or batter in the other. With the former he pulls the canes over the harvester, and with the paddle or batter knocks the fruit off. This sounds like a rough method, and is not as gentle as might be desired, but for berries which are to go at once to the evaporator it has been found entirely satisfactory. Of course, more or less leaves and twigs are gathered with the berries by the harvester method, but they can be removed by fanning and picking at considerably less cost than by hand picking of the fruit. It will cost about one-half cent a quart to gather with the harvester method, as against one and one-half or two cents for picking.

For this method the fruit is allowed to become very ripe and the entire crop is gathered in two, or at the most three, times over the plantation in the season.

MARKETING

Except in those sections of the country where the growing of raspberries and blackberries has been so largely developed as to become one of the leading industries (Fig. 124) there is usually a good local demand for the fresh fruit, and this is by all means the best type of market. Even a relatively small town will take the entire output of a good-sized plantation if the fruit is put up well and, in particular, if it is delivered to the customers fresh and ripe. That is where the local man can score every time.

FIG. 124.—Delivering berries at the Puyallup Association warehouse.

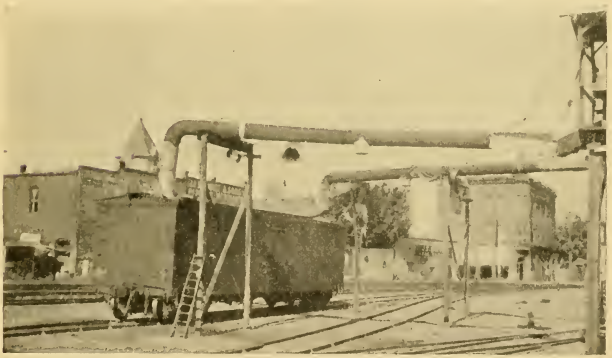

FIG. 125.—After loading, cars are pre-cooled by forcing currents of cool air through them, requiring about forty minutes.

Where the industry is highly developed shipping in cooled cars or refrigerators is often necessary (Figs. 125 and 126).

Boxes and Crates.—Red raspberries are marketed almost exclusively in the oblong, pint boxes (Fig. 127.) The few exceptions to this rule are markets which have always had the

quart size and are too conservative to change. The advantages of the pint over the quart for red raspberries are, first and by far the most important, that the fruit is not so likely to be damaged by the weight of the berries themselves, and second, that better prices can be realized for them since customers are quite reconciled to pay more than half as much for a pint as for a quart.

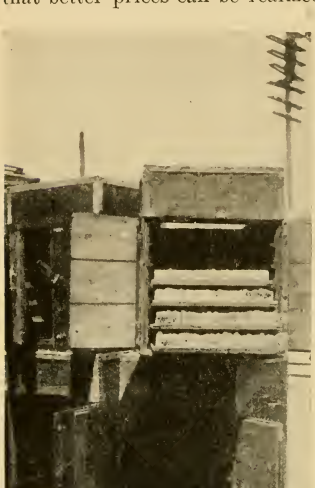

FIG. 126.—Pony refrigerator used in shipping berries in less than carload lots to distant markets. Each refrigerator holds 60 pints and 20 lbs. of ice.

For blackberries and black raspberries the quart boxes are almost always used, since the firmer texture of these berries does not require the small package. Occasionally, however, markets are found which prefer the pints for these as well as the reds.

The crates used for these berries vary considerably, but the thirty-two-quart size is the most popular, take the country as a whole (Fig. 79). This holds thirty-two of the quart boxes or sixty of the oblong pint boxes. In some sections, notably in the Pacific Northwest, the flat twenty-four quart crate is used almost exclusively (Figs. 128 and 129).

Drying.—In many sections the growing of black raspberries for the especial purpose of drying them for market is a large and prosperous industry. Blackberries are sometimes grown for this purpose, and to a much less extent the red raspberries are used, but the shrinkage is so great with them both that they are not nearly so profitable as the firmer fleshed and more seedy black raspberries.

A quart of red raspberries will give, on the average, a little less than a quarter of a pound of the dried product, so that the grower will secure perhaps seven or, at the most, eight pounds

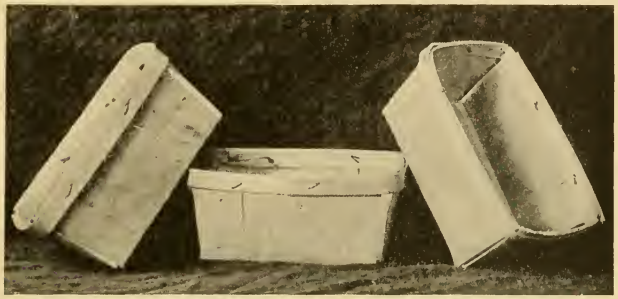

FIG. 127.—Oblong pint boxes, the most popular type for raspberries, especially the reds.

FIG. 128.—Type of crates used in Washington and other western berry sections. Each crate holds 24 boxes.

per bushel of fresh fruit. With the black raspberries ten pounds per bushel are not uncommon. Of course, the amount of dried fruit secured from a bushel varies greatly with the season. In the early part, when the growth is more active, or in seasons

when moisture is abundant, a quart of fresh fruit will give less dried product than when growth is less active and moisture less abundant.

Another point against drying the reds is the fact that the dried product takes on an unattractive, dull red color, so that they are not nearly as salable as the dried black raspberries.

In sections where the evaporating industry is well established so that plants for the purpose are plentiful, it is a fairly common custom to market the first part of the crop of reds or black-

FIG. 129.—Packing crates in the car for shipment. Each crate is held in place by laths nailed to the top. About 600 crates are placed in each car.

berries in the fresh condition, and then dry the last end of the crop when the berries are poorer and the picking cannot be done so rapidly, or at any time during the season when the market for fresh fruit is particularly poor.

Devices for Drying.—The evaporating of these fruits is done in a small way at home by various devices, from a simple tray or pan placed in the oven or top of the stove, to more or less complicated patented devices which can be used in connection with the ordinary kitchen stove or may have special heating apparatus of their own. One of the best of these home types is an evaporating pan with a double or jacketed bottom. The

space between the two bottoms is water-tight, and when in use this space is filled with water, the evaporator is placed on the back of the stove and the pan filled with the berries. The great advantage of this type is the fact that so long as water is kept in it there is no possibility of the fruit being scorched.

For commercial work two or three general types of evaporators are in use. The simplest method is to dry in the sun, and where weather conditions will permit this method is often used. The objections to it are that it is slow, and that flies and other insects are attracted in such numbers as to render the product not attractive to one who knows how it was cured.

A second method is to utilize greenhouses, which has the advantage over the last method of protecting the fruit from dampness of dews or rain, and of increasing, very decidedly, the temperature. With proper attention the fly nuisance may also be somewhat abated.

Commercial Drying Plants.—By far the best and most popular method in commercial work is the use of some type of evaporator. These vary greatly in style and management. As a rule, hot-air furnaces are used, but occasionally steam is employed as a source of heat.

The plant generally consists of a small building with the furnace and stack for drying at one end. In some cases the fresh fruit is put in on trays at the bottom of the stack and gradually raised as other trays are put in until it reaches the top of the stack in a dried condition and is taken out on the upper floor of the building. In other plants this procedure is reversed, the fresh fruit being put in at the top of the stack and the dried product taken out at the bottom. The advantage claimed for this latter method is that the fruit dries more rapidly because the vapor from the fresh fruit does not pass upward through all that which is partially dried. The objection to it is that the upper story makes a somewhat better place to store the dried product and that there is more labor involved in taking the fresh berries to the top story.

Canning and Preserving.—Besides being used in a fresh state and dried, blackberries and raspberries may be canned

(Fig. 130) or made into jams and occasionally into jellies. The last two are usually either strictly home propositions, or else they are used where a special local market can be developed. But canning of these berries is a large and important industry, and with blackberries a much larger proportion of the commercial crop is canned than dried. They may be put up in sugar of varying percentages, or canned without sugar, being merely sterilized by heating, and the sugar added at the time the fruit is used.

Yields.—It goes without saying that yields will vary greatly.

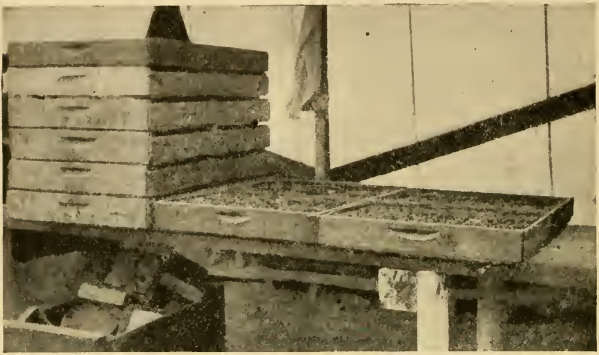

FIG. 130.—Crates of berries for the cannery. Berries too soft for shipment are canned.

Factors influencing the yield are the locality, the grower, the variety, and the age of the plantation. With all these influencing the result there is little value, perhaps, in figures, but the following table may be of interest, giving the yields per acre:

Berry	Low Yields	Average Yields	High Yields
Red raspberry	1000 qts.	2200 qts.	4000 qts.
Black raspberry	1200 qts.	2400 qts.	4800 qts.
Blackberry	1400 qts.	3000 qts.	6000 qts.

QUESTIONS

1 How would you tell when blackberries were ready to pick? On what does this depend?

2 Have you ever picked raspberries? How do you tell when the red varieties are ripe enough to pick? The black varieties?

3. How would you reduce to a minimum the trouble from the thorniness of these fruits?
4. Discuss the handling of these berries as they are picked.
5. What is the objection to picking berries when they are wet? Can this always be avoided?
6. How often ought raspberry plantations to be picked over?
7. Describe the berry harvester. Did you ever see one in use? What do you think would be the objections to one?
8. What crates and boxes are used for these berries?
9. Describe the evaporating of raspberries.

CURRANTS AND GOOSEBERRIES

CHAPTER XXIII

SITES, SOILS AND THEIR PREPARATION FOR CURRANTS AND GOOSEBERRIES

The requirements of currants and gooseberries as to locations and soils are practically identical. Both plants, in their wild state, are inhabitants of north temperate regions, or of high altitudes, where the mean summer temperature is relatively low. And both thrive under partial shade, being found for the most part in our northern woods. Doubtless this preference for shady locations is in part due to the fact that the shade tends to keep the temperatures low.

As to soils the preference of the wild forms is for the heavier types, a clay loam being perhaps the ideal, and even the rather heavy clays being popular with both plants. They will often be found growing upon somewhat lighter soils, provided that these are low-lying or are exceptionally well supplied with humus, so that in any case the supply of soil moisture will be abundant and constant.

Taking the foregoing as indicating the preferences of these plants in their natural state, and checking them up with the conditions under which the commercial growing of currants and gooseberries is most successful, we may lay down the following principles as those which ought to be considered in locating a commercial plantation of these fruits, or in growing them for home use.

Localities.—To be most successful these fruits should be grown in the northern parts of the United States, or across the line in Canada, or else in mountainous regions where the high altitude produces a climate similar to these northern sections. They will not, as a rule, do their best south of Ohio. As one gets away from these regions which are the natural habitat of these fruits, it will be found that they are more subject to diseases, requiring more spraying to keep them healthy; and even where they are not attacked by disease they are not likely to be as

productive. The grower, therefore, who contemplates establishing a plantation of either of these fruits as a part of his fruit-growing venture, ought to consider carefully whether he can give them the natural conditions that they need. If he cannot they are not likely to be as satisfactory as some other fruits, either for the local markets, which is the natural outlet for them, or to be shipped to more distant markets where they will come into competition with fruits grown in more favored sections.

Sites.—Within any region, and even on any particular farm, there will be a marked difference in the desirability of different fields or sites for these fruits. Some of the factors which ought to be considered in selecting the site are the following:

1. **A northern or northeastern exposure** is almost always to be preferred. It is only as one approaches the northern limit of the successful culture of these fruits that this factor can be ignored if the best results are to be secured. The advantages of the northern slope are two: First, that it is cooler, and second, that it is not so much exposed to the dry southerly winds. In both cases, but especially the first named, it is surprising how slight a slope will prove effective. It is not necessary that the slope should be much more than enough to drain the land thoroughly of surface water in order to produce a marked difference in the temperature of the soil. Men who grow early strawberries, or who grow cantaloupes somewhat out of their natural range, soon learn what a slight slant to the south is necessary in order to produce a decided difference in the temperautre of the soil. And the reverse is equally true when one wishes to keep the soil cool.

The law in physics in the case is that the amount of heat absorbed directly from the ray of sunshine varies with the angle which this ray makes with the surface of the field. If the slope is to the south and is sufficiently steep so that the sun's rays strike the surface of the field at a right angle, then the soil will get the largest amount of heat possible directly from the sun. On the other hand, if the slope is to the north and is steep enough so that the sun's rays fall parallel to the slope, then no heat is absorbed by the soil directly from the sun's rays. In this latter

case the soil must get what heat it does acquire, not direct from the sun, but indirectly from the air. Between these two extremes we have, of course, all intermediate grades or steps in the absorption of the sun's heat by the soil.

1. **Drying winds** are even more to be dreaded than the hot sun, and while perhaps the northern slope is not quite so effective in stopping their effect, yet it is a great assistance and ought to be taken advantage of whenever possible.

2. **Higher elevations** are usually to be chosen, other things being equal. Of course, other things seldom are equal and it then becomes necessary to use one's judgment as to whether elevation or some other factor is the more important. But the fact ought never to be lost sight of that no great difference in elevation is required to make a very substantial difference in the temperature of two fields. It is a matter of common observation that even a hundred feet difference in elevation may cause enough difference in temperature so that the first snow comes earlier and does not melt nearly so quickly.

3. **Air drainage** is apt to be important for two reasons: First, because these fruits bloom very early and are therefore likely to be caught by late frosts, and second, because some varieties in some sections are subject to fungous diseases which are encouraged by poor atmospheric drainage. If, therefore, the slope can be not only to the north but sufficient to give good air drainage the ideal location will have been secured.

4. **Moisture Conditions.**—Occasionally lower levels may be preferable because the moisture conditions are better there. This is more likely to be the case as one gets farther north, where the mean temperature is lower, but it may happen even in sections which are fairly well to the southern part of the range of these fruits.

5. **Shade.**—A last factor which ought to be considered in this matter of site, whether it be a commercial plantation or one for home use, is shade. The currant and gooseberry not only tolerate partial shade but in many sections are the better for it. This is particularly the case where the mean temperature tends to run too high to be ideal. For small home plantations the

north side of a building or even of a board fence may be utilized for the currant or gooseberry patch, and even those bushes which are too far away to be shaded will be benefited by the shutting off of the south wind.

Another very common practice is to set them between any fruit trees which may be growing in the garden, as is shown

FIG. 131.—Currants and gooseberries grown under fruit trees in the garden. They succeed well in such locations, preferring partial shade to too much sun.

in figure 131. Here they will usually do very well if they are not too thoroughly neglected, which they generally are.

Commercially it is rarely possible to give these fruits any shade except as they may be grown in orchards, and this is not a good practice from the standpoint of the orchard, and frequently not from that of the currants or gooseberries, because neither can be given as good culture as where the two plantations are separate.

Soils.—The ideal soil, as already suggested, is a heavy soil. It ought seldom to be lighter than a clay loam, though some of

the silty soils may be utilized satisfactorily, provided that the site is good in other respects.

Since one reason for preferring the heavy soil is its coolness, it follows that as one goes north the importance of a heavy soil decreases until one might conceivably be justified in using even a fairly light sandy loam if the soil were ideal in other respects.

An abundant and continuous supply of moisture being one of the principal requirements of the soil for these plants it follows that humus is an all-important matter, and a lighter soil which is well supplied with it might be used, while a fairly heavy soil which is deficient in it would not be successful with either currants or gooseberries.

QUESTIONS

1. What type of soils do currants and gooseberries prefer?
2. What exposure is best for them?
3. Where are the most successful currant growing regions?
4. What elevation would you choose as a site for a gooseberry plantation?
5. Discuss air-drainage as it affects a currant plantation.
6. Have you seen successful plantations of currants or gooseberries in your own section? Where were they located?
7. How does shade affect these fruits?

CHAPTER XXIV

VARIETIES AND PROPAGATION OF CURRANTS AND GOOSEBERRIES

The currants and gooseberries form a very interesting group botanically. They all belong to the genus *Ribes* and from this by some authorities are called Ribaceous fruits; while by others they are grouped together under the name of Groselles.

Varieties of Currants.—The cultivated currants are derived mostly from two species, both of them of European origin. The red and white varieties are cultivated forms of *Ribes vulgare,* while the blacks are from *Ribes nigrum.* There are a few varieties in cultivation which have come from some of our native American species (the Crandall, for example), but they are very little prized and very seldom grown and need not be considered here.

Commercially the red varieties are practically the only ones grown. The white varieties are apt to be milder in flavor than the reds and are highly prized for home use, particularly where the fruit is eaten in a fresh state, but they are practically never grown for market.

Leading varieties of currants are the Cherry, Fay, Perfection, Red Cross, and Wilder among reds; the White Grape and White Imperial among whites, and the Naples, Prince of Wales, and Champion among blacks.

Black currants have a peculiar, strong flavor and odor, and while they are highly prized in England and Canada, they have never become popular in the United States. There is, therefore, likely to be a very limited demand for them in any section of the United States; but those who want them, want them badly and will pay good prices for them, so that the commercial grower might well consider the advisability of growing a few of them on his plantation.

Types of Gooseberries.—There are two general and fairly

distinct types of gooseberries in cultivation, the European or English type, and the American type. The varieties of the European group are cultivated forms of the species *Ribes grossularia,* the wild gooseberry of Europe, and are characterized by much larger fruit and by a smaller, more compact and upright growing bush than the American form.

The botany of the American group is not so clear. Apparently most of them have come from the species *Ribes hirtellum,* yet several which are ordinarily classed as American varieties very probably are hybrids between *Ribes grossularia* and probably *Ribes hirtellum.* But if they are hybrids the characters of the parent American species are much more prominent in the offspring than those of the European parent (Fig. 132).

FIG. 132.—Types of gooseberries. English varieties at left, American at right.

Varieties of Gooseberries.—While the list of gooseberry varieties is considerably longer than that of currants, yet the number of sorts grown commercially, or even for home use, is comparatively short. Among the European varieties Industry is far more commonly grown than any other, with Chautauqua and Crown Bob as varieties of secondary importance, while of the American group Downing is the leader, with Houghton, and Pearl as popular seconds.

Propagation of Currants and Gooseberries.—No fruits are more easily propagated than currants and gooseberries, and several different methods of propagation are in use. Hardwood cuttings, single-eye cuttings, layers and green cuttings are all of them used to a greater or less extent, but the hardwood-cutting method is the only one that is used to any great extent commercially. For this purpose straight cuttings of one-year wood, such

as is shown in figures 133 and 134, are taken. They should be from six to ten inches in length, but usually about eight inches. These may be cut at any time after the leaves fall and are handled in a number of different ways. Whatever the method of handling is to be the wood is cut into the desired length and made up into bundles, being careful to have the butts all one way. These bundles are then buried with the butts up in a well-

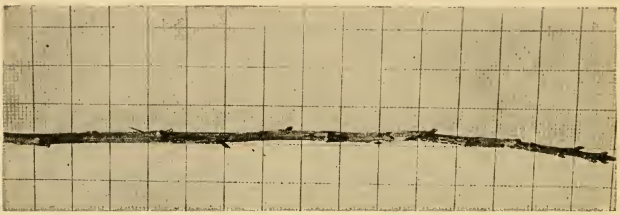

FIG. 133.—A one-year cane of the currant. Such wood is the only type satisfactory for cuttings.

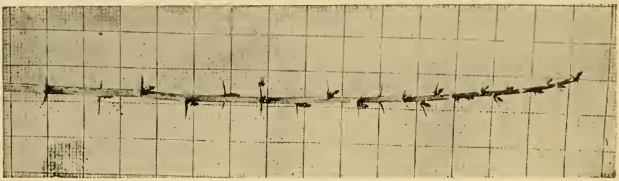

FIG. 134.—One-year shoot of the gooseberry. Such wood will produce some of the best of the fruit.

drained spot with a mellow soil and are covered with two or three inches of soil. Here the butts of the cuttings form a callus and may even start roots.

If the cuttings have been made early in the autumn they will callus in time so that they may be taken up and planted out in nursery rows before the ground freezes; and this is a common practice. If they are not to be set out that autumn they are commonly left buried over winter, some additional protection being given them in the shape of a mulch to prevent the tender roots from being damaged.

Another common method is to make up the cuttings later in the season and store them in sand in a cellar where they will not freeze. They are then set out in nursery rows early the following spring. Spring planting of cuttings must be done very early, however, or the cuttings will have started too much, as they begin growth at a comparatively low temperature.

Setting the Cuttings.—In setting out the cuttings, whether it is done in autumn or spring, several different methods are used: First, the land may be furrowed out and the cuttings planted in the furrow; or second, they may be set with a spade; or third, they may be set with a dibble. In any case, the cutting is put down deep enough so that only two buds are left above the surface of the ground and the soil is tramped very firmly about them. If set in the fall a light mulch of straw or manure should be applied along the rows, or a furrow may be plowed over them and this soil raked off in the spring.

For commercial purposes or for home use if a good growth is desired the cuttings should be planted in a rich, deep soil. Here they will grow vigorously and will make large enough plants, so that they will be of a marketable size at one year. This is very desirable, as most growers have a decided prejudice in favor of one-year plants.

Single-eye cuttings are seldom used except where the wood is very scarce. When used they are handled much as the longer cuttings, but are covered over entirely when set, the cutting being placed with the bud up and covered to the depth of about an inch.

Layers are used commercially by some nurserymen. For home use, where only a few new plants are desired, the method works out very well and is more generally used. The branch is bent down and covered with earth where it strikes roots readily. The new plants are transferred to the new row the following season. As a matter of fact, one can usually find quite a number of these layers which have rooted of themselves, the low-lying branches becoming slightly covered with earth and leaves, and striking roots abundantly.

QUESTIONS

1. From what genus and species of wild fruits are currants derived?
2. How have we developed the cultivated gooseberries?
3. What are the best varieties of currants for your section?
4. What are the best gooseberries? Are they English or American varieties?
5. Describe the propagation of currants by cuttings.
6. How are gooseberries propagated by layers?
7. When and how would you propagate these fruits by single-eye cuttings?

CHAPTER XXV

ESTABLISHING CURRANT AND GOOSEBERRY PLANTATIONS

The first essential in starting a successful plantation of currants or gooseberries is to have the soil thoroughly prepared. No treatment after the plants are set can make up for neglect in this particular. If possible these fruits ought to follow a cultivated crop, preferably such a crop as beans or potatoes or a truck crop where good fertilizing and thorough cultivation are practiced. And, in any event, it is usually best not to plow under a heavy sod for them, but to introduce one of the crops suggested above between the hay crop and the currants or gooseberries.

Soil Preparation.—The land should be plowed deeply, and even for spring setting it is much better to plow in the autumn. Eight inches will be found none too deep and ten inches may be even better. If the subsoil is at all compact, as it frequently is with the types of soils selected for these fruits, it may pay well to follow the regular plow with a subsoil plow in order to break up this compact under layer. The main object in this preparation is to secure a deep soil which may act as a reservoir to hold soil moisture and give it up as needed.

After plowing, the land should be worked very thoroughly, going over the land at least twice, and preferably three times, with a disk harrow. The first time over should always be in the same direction as the plowing, and probably the second time also; but if a third disking is given it may well be at right angles to the plowing. Follow the disk with at least one other type of harrow, and finish off with the drag or planker. This leaves the land in the best possible condition for laying off, and the soil is also in the best possible condition to receive the plants, being thoroughly pulverized but not so loose as to dry out readily.

Distances Apart.—The land is next marked out for setting

the plants. As with any other fruits, the distances recommended vary greatly, being all the way from two and one-half or three feet by four, up to five or six by eight feet. The distance which ought to be chosen will vary with at least four factors:

First, the soil. If this is heavy and fertile the distances ought to be greater than if it is lighter and less fertile.

Second, the variety. The English gooseberries, as Industry, or some of the smaller growing currants, might do well at three feet apart. The large-growing American varieties of gooseberries, as Houghton and Pearl, or the larger and spreading types of currants, as Fay, may need five feet or even more.

Third, the culture and fertilizing to be given. With good culture and high fertilizing the plants will demand much more room than with less intensive methods.

Fourth, the method of cultivation to be practiced. If the plantation is to be kept under intensive cultivation and hand labor is to be used to a considerable extent, then the plants may be set closer than when all the cultivation is to be done by horse cultivators, and where it will be necessary, or at least desirable, to introduce such an implement as the grape hoe.

With these factors in mind the following distances may be suggested—rows four feet apart and plants three feet in the row, or with the hill system, plants four feet apart each way—as minimum distances. And rows seven feet apart and plants four feet apart in the row, or with the hill system, plants six feet apart each way, as maximum distances. Probably four feet by six feet for rows, and five by five feet for hills, are the most generally satisfactory and most commonly used distances.

The marking and setting may be done in several different ways, depending largely upon the size of the plantation to be set. With large fields it is common to lay off the rows in one direction with a marker and then plow deep furrows in the other direction, setting the plants at the intersections of the marks and the furrows. With smaller plantations the land may be marked both ways with the marker and the holes dug with a shovel.

Spring or Fall Planting.—Both spring and fall plantings are

practiced. There is one rather strong argument in favor of fall planting, and a second one which has considerable weight.

The first argument is that both of these fruits, but especially gooseberries, start very early in the spring. It is nothing uncommon to find the buds well swollen when the snow goes off in the late winter or early spring, and the very first warm days are sure to bring them on rapidly so that before such trees as apples and pears begin to show the slightest sign of starting growth the gooseberry row is quite green. It is therefore very difficult to get them into the ground in the spring before the leaves start, and if this is not done the subsequent growth, at least for that year, is likely to be disappointing.

The second argument is that these fruits ripen their wood very early in the autumn and the leaves drop of themselves in plenty of time for the plants to be dug from the nursery rows for setting. This avoids one of the most serious objections to setting orchards in the fall, *viz.,* that the young trees do not shed their leaves and consequently the leaves have to be "stripped" or removed from the trees by hand, which usually means poorly ripened stock.

On the other hand, in changeable climates, or in sections where the winter climate is likely to be very dry, there is frequently a great deal of winter injury to the newly-set plants. This winter injury can be greatly reduced and frequently prevented altogether by some slight protection to the newly-set plants. Either straw or strawy manure sprinkled lightly along the rows will, to a large extent, prevent the alternate freezing and thawing of the soil or the serious drying out of it. These factors are usually responsible for most of the damage done.

On the whole, setting very early in the spring is probably best, especially if the plants can be dug the autumn before and stored where they will not get the sun's rays, preferably burying them entirely with earth. Next to this very early spring planting would stand autumn setting, with late spring setting bringing up the rear and a long way behind.

The plants are prepared for setting by trimming back the roots from one-third to one-half, and usually by cutting back the

tops more or less, though this latter is less common than shortening the roots. The cutting of the roots may be done on a chopping block, using a sharp hatchet or a heavy corn knife, as is done with strawberries. The tops may be pruned back in the same way, though it is a bit crude, and a pruning shear is often preferred.

Methods of Setting.—The land having been marked off, the plants are set in various ways. If furrows have been plowed in the laying off of the land then the plants are set against the upright or land side of the furrow, at the points where the cross-marks intersect the furrows, and the earth is shoveled back onto the roots and tramped down firmly. In some cases it may be necessary to shovel out a little of the loose earth from the bottom of the furrow, but usually not if the furrow has been plowed as deep as ten inches.

Where the land has been marked both ways the holes are dug with a shovel and the plants set as trees would be, or they may be set with a spade without digging any hole, as strawberries are often set and as is shown in figures 42 to 45.

Whatever method is used it is essential that the soil be pressed very firmly about the roots. This is a crucial matter with autumn setting because, at best, the plants will be none too firmly in contact with the soil; and with the heavy types of soils, generally chosen for these fruits, "heaving" of the plants in winter is a common difficulty.

The plants are generally set somewhat deeper than they stood in the nursery rows, and like all plants which tend to throw up shoots from about the crown, there is little danger from setting them considerably deeper than they originally stood.

Cultivation After Setting.—It is advisable, particularly if the weather is dry, to run the cultivator through the plantation just as soon as the setting is finished. The need of this is lessened very decidedly if the men in setting are careful to leave a little loose earth about each plant. But since this cannot always be depended on, and since the soil between the rows is always tramped down rather solidly, it is safer and generally better to do the cultivating.

QUESTIONS

1. How would you prepare the soil for a currant plantation?
2. How far apart would you set English gooseberries? American?
3. On what other points than the type or variety does the best distance depend?
4. How would you lay off the land for such a plantation?
5. Would you set currants in spring or fall? Why?
6. How would you prune a gooseberry bush for setting?
7. Describe the setting of the plants in a currant plantation.

CHAPTER XXVI

CULTURE AND FERTILIZING OF CURRANTS AND GOOSEBERRIES

Few fruits are more often or more thoroughly neglected than currants and gooseberries by owners of garden plots, and even by the commercial grower, and yet few will respond more bountifully to really good treatment.

Culture Difficulties.—Starting their growth as they do very early in the spring the season's campaign of culture ought to start equally early if an adequate and timely supply of moisture and plant food is to be provided. The first problem each season is to get the land thoroughly well fitted in the spring and it is not always easy to solve this problem satisfactorily. Two factors make it somewhat more difficult than with most other fruits:

First, these are shallow-rooted plants, and therefore any very deep stirring of the soil is not desirable. The roots may, of course, be forced to go somewhat deeper by practicing fairly deep cultivation from the start, but even with this treatment the roots are still comparatively near the surface of the soil.

Second, the plants are not usually very far apart, and are always rather spreading so that there is comparatively little room for manipulating whatever implements may be chosen for the work.

Implements for Tillage.—Where fairly deep stirring is desired, owing to having considerable material to turn under, or because one is anxious to get as large a reservoir as possible for holding water, the gang plow shown in figure 2 is the best implement to use. In fact, it is the heaviest implement that ought to be used on these plantations except under special conditions. It can easily be run at a depth of five or six inches, and this is deeper than is ordinarily desirable, unless it might be in the center of the rows and where the plants are rather widely spaced. For most conditions a heavy-toothed, V-shaped cultivator, such as is shown in figure 9, will be found entirely

adequate for the spring preparation of the currant or gooseberry plantation. It should be run through the plantation several times, the first time being just as early in the spring as the soil is sufficiently dry. If this cultivator is run through the rows twice, lapping it well, and then two or three days are allowed to go by before the next working, the soil which has been loosened up will have time to dry out a little, and the second working of it will bring it into better shape than if the same amount of labor is put on it all at one time. Of course, this presupposes that the soil has first been allowed to dry out until it is in the proper condition to be worked. If it is too wet for working then the lapse of these two or three days may not be desirable, as the lumps which are turned up may bake hard and be more rather than less difficult to pulverize later. In case the gang plow is used it may be followed by this heavy cultivator.

Frequent Shallow Tillage.—Later cultivating ought to be very shallow, and it is best done with a spike-toothed or harrow type of cultivator (Fig. 10). It should be frequent, once every week or ten days, even though there may be no weeds to contend with. When the plantation is set so as to allow of cross-cultivation the great bulk of the work can be done with the horse, but a certain amount of hand hoeing will be necessary even here; and where cross-cultivation cannot be done considerably more hoeing will be needed. The older the plantation the more of this hoeing it will be necessary to do. In plantations where witch grass is not prevalent, hoeing is rarely a serious matter; where witch grass does get a firm hold it is a question whether the most sensible thing may not be to pull the plants out and begin again.

The ideal should be to keep the soil from getting hard and dry, and, of course, to keep it free from weeds. Whatever culture, either with hoes or cultivators, may be necessary to secure this ideal must be given if the best results are to be secured from the plantation.

After the crop has been harvested a special effort should be made to get the soil thoroughly worked up again before a cover crop is sown. In this campaign the large-toothed cultivator may well be used again. Follow this with the lighter type.

The cover crop is exceptionally important in these plantations for several reasons, and ought to be selected with unusual care. To begin with the soils are usually rather heavy and will therefore need as large an amount of humus as possible. Therefore a large-growing crop should be chosen. Then since the crop of fruit is harvested rather late, the date of sowing is therefore somewhat delayed, and it becomes a somewhat difficult question to choose a crop which, starting thus late, will still give enough growth before the close of the season. Another factor which one must consider is that no cover crop should be used which is likely to become established close about the plants and which therefore will require much hand labor to subdue it. One should have a crop which starts quickly, as the checking of weeds on the plantation is of unusual importance, as compared with orchard fruits, where larger implements may be used for subduing the weeds.

All these requirements are difficult to satisfy; in fact, they cannot be met altogether, but some mixture of cover crops will come nearer to being satisfactory than any single crop. For a large-growing crop to supply humus and smother out weeds probably buckwheat will stand at the head, with barley as a substitute which may be used with a good degree of success. Of course, this does not provide for any nitrogen, and for this purpose some clover or winter vetch probably ought to be added. A half bushel to a bushel of buckwheat or barley per acre, with six or eight pounds of clover seed, or ten pounds of winter vetch seed added, makes an excellent combination. When the soil of the plantation is well supplied with the seeds of large-growing but easily-subdued weeds, such as the various types of large pigweeds (Amarantus retroflexus and Chenopodium album, if one is botanically minded), the buckwheat or the barley may well be omitted from the above mixture and the weeds allowed to take its place.

Mulching.—In home plantations, or occasionally in the smaller-sized commercial plantations, some method of mulching may be resorted to in lieu of cultivation. This is ordinarily of rather doubtful value for several reasons. To begin with, it

brings the feeding roots, and, in fact, nearly the whole root system, very close to the surface of the soil, and in seasons of very severe drought the plants are pretty sure to suffer for moisture in spite of the mulch. Moreover, it is generally difficult to secure a sufficient supply of whatever material is adopted for the mulch, so that the covering applied is apt to be rather scant. Then, too, the cost of the material is considerable on a plantation of any size, and lastly, the mulch, even under the best of conditions, does not usually perform the desired functions as well as cultivation does. With all this against it the method is sometimes used, especially on home plantations, and for this purpose the best materials are clean straw and old hay. If possible hay or straw should be selected which carries no seeds of weeds that are likely to prove troublesome on the plantation.

Duration of the Plantation.—One of the most important questions which is indirectly tied up with the question of cultural methods is the duration of the plantation—the length of time that it will be profitable to continue it (Fig. 131).

Influence of Weeds.—Of course, the principal factor in the management which influences this duration is the degree to which the weeds are kept in subjection. If they are kept thoroughly subdued, and especially if enough hoeing is done so that they do not become established close about the bushes, then the plantation may be kept for many years. But if cultivation is neglected, and if witch grass or some such weed becomes established in the plantation, then it will usually be found best and cheapest to pull out the bushes and replant on new ground.

Influence of Type of Pruning.—Another factor which has a very important bearing on the duration of the plantation is the type of pruning that is practiced. As the bushes get older they throw up fewer and fewer of the strong young shoots, such as are shown in figures 133 and 134, unless some special effort is made to induce such growth, and heavy pruning is the best method to encourage growth of this type. Occasionally it may be found desirable to cut away the bush entirely and allow the plant to grow a new top, but ordinarily it is only necessary to

practice severe pruning. This is fully discussed under the chapter on pruning.

Influence of Diseases and Insects.—Another factor which influences very decidedly the length of life of the plantation is the gradual increase of diseases and insects, especially the former. If these are kept in thorough subjection the yields and quality of fruit may be kept up for a long time, while if they are neglected they very soon render it unprofitable.

Influence of Fertilizing.—A last factor in the problem is liberal fertilizing, to which we shall next turn for a full discussion. As a result of these four factors—weeds, pruning, fertilizing, and pests, and the degree to which they are controlled in the interests of the plants—we find that the life of a plantation of currants or gooseberries will vary from six to twelve years. As the cost of replanting is not serious, and as the plants come into bearing quickly, bearing some fruit the third year after they are set, and furthermore, as the fruit is much larger and better on young and vigorous plants, the practice among the best growers is to renew at the shorter rather than the longer period suggested.

In regard to fertilizing, the practice, even among commercial growers, varies greatly, particularly on the side of nitrogen. Both of these fruits are very rank feeders, and, unlike many other fruits, are not easily damaged by too vigorous a growth; that is, they are not made more liable to winter injury by heavy growth, and they do not grow wood at the expense of fruit. It is, therefore, safe to give them an abundance of nitrogenous fertilizer, especially as the plantation gets older.

Use of Manure.—Where it is possible to secure it, barnyard manure and poultry manure ought to make an important part of the annual fertilizing. This is preferably applied in the autumn or winter, unless one has very well-rotted manure available, or unless the land is so sloping as to endanger serious loss from the manure washing away. A fair application of manure each year would be, say, five cubic yards per acre. If this cannot be used then the nitrogen must be supplied through fertilizers, and probably a combination of tankage and nitrate of

soda will give as good results as anything, the nitrate furnishing the nitrogen for the first start in the spring, and the more slowly available tankage taking care of the later growth.

Some Good Applications.—The following are three formulas which have been secured from practical growers of these fruits:

I.	Barnyard manure.....	5 cubic yards (applied in autumn)
	Bone meal	300 lbs.
	Wood ashes 1000	lbs.
II.	Slag	800 lbs. (applied in autumn)
	Tankage	300 lbs.
	Muriate of potash	100 lbs.
III.	Slag	600 lbs.
	High grade sulfate of potash	300 lbs.
	Tankage	300 lbs.
	Nitrate of soda	100 lbs.

The fertilizers are best applied with a sower and should be delivered relatively close to the plants, since the roots of these fruits do not forage widely.

QUESTIONS

1. Are currants and gooseberries generally neglected or well cared for in your section?
2. Why do they need early cultivation?
3. Describe the root system of a currant. Did you ever see anything to make you think it was a shallow-rooted plant?
4. What implements would you use for cultivating a plantation of these fruits?
5. Outline the season's cultivation for a plantation of currants.
6. Would you use a cover crop with these fruits? If so, what one in your own section?
7. What would you consider was the most important thing that this crop would do for the plantation?
8. How long will a plantation of currants usually be profitable? What are the principal reasons for discarding it?
9. How can you prolong the life of a gooseberry plantation?
10. How would you fertilize a plantation of these fruits?

CHAPTER XXVII

PRUNING AND TRAINING CURRANTS AND GOOSEBERRIES

The bearing habit of the currant and that of the gooseberry are essentially the same, and therefore the pruning is, or ought to be, very much the same. But since the fruit is borne on several different types of wood the pruning is by no means as

Fig. 135.—Good distribution of fruit on gooseberry canes. Note side spurs well loaded. The previous winter this cane resembled figure 136.

exact a science as it is with raspberries or with grapes. With a raspberry there is only one possible place for the fruit to grow, and that is on side shoots from the canes which grew the previous season. All other wood can therefore be ignored in our study of the fruiting system.

Three Types of Currant Wood.—With the currant, on the other hand, there are many parts of the plant where fruit may

grow. If we examine a reasonably thrifty currant bush it will usually be found that there are three fairly well-defined types of canes on it, though just what proportion there is of each type, and indeed, whether some of them will be found at all, depends on the previous pruning and culture which the bush has received (Figs. 135 and 136).

The three classes represent three different ages, and except

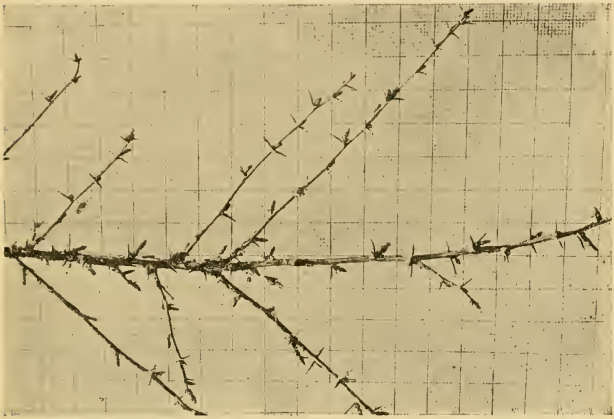

FIG. 136.—Good fruiting wood of the gooseberry; vigorous buds, long one-year side shoots, and good terminal growth.

for the first class no well-defined line can be drawn to separate them as they gradually shade into one another.

1. In the first place, there are the strong young canes which grew the previous season and which start from around the crown of the plant. They are light grayish in color and very straight in growth with fairly long nodes or joints and rather prominent buds (Fig. 133). They are found most abundantly during the earlier years of the life of the plant and, of the three classes of canes mentioned above, are the most likely to be lacking altogether. They indicate vigor of growth, and anything which tends to the vigor of a bush tends to increase their num-

ber and strength; for example, severe pruning the previous year, thorough cultivation, or the abundant application of nitrogenous fertilizers all tend to produce them. Usually they bear abundantly the following season (Fig. 137).

FIG. 137.—Distribution of fruit on one-year gooseberry wood. Large and abundant fruit.

FIG. 138.—Currant wood which is too old to give good fruit. Very short terminal growth.

2. In the second place, we have, at the other extreme, the very old canes which are getting past, or have already passed, their usefulness. The bark on these is rough and black, and whatever fruit they bear is produced on spurs and short branches along their sides, which have usually made very little growth

FIG. 139.—Section of currant cane too old for good fruit. Small clusters of small berries, and few and small leaves. Also black bark and dead spurs. All such wood should be cut out in pruning.

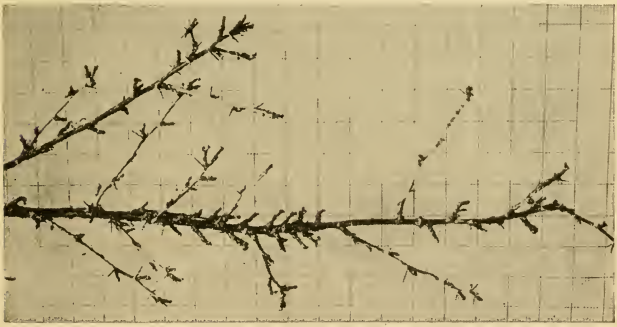

FIG. 140.—Gooseberry wood that is too old for good fruit. Note short growth and many dead spurs. Such canes should be cut out in pruning.

the previous season. The fruit on these canes is poor, the clusters being comparatively few and small, and the individual berries small, as is shown in figures 138, 139 and 140.

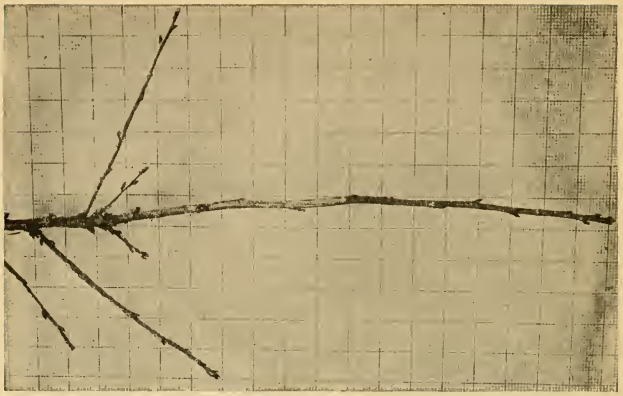

FIG. 141.—Terminal growth on a young and vigorous currant cane. Such wood will produce an abundance of fine fruit. Compare with figure 138.

FIG. 142.—Fairly good bearing wood of currant, but not enough growth to insure the best fruit.

3. The third class of canes is intermediate between these two and consists of a lower portion with strong vigorous side shoots and an upper straight terminal shoot which grew last season. The bulk of the fruit on any bush will be found on this class of canes, some of it being found on last year's extension at the top of the cane, much of it on the side spurs and

FIG. 143.—Distribution of fruit on a one-year section of a currant cane. Note thick clusters of bunches at junction of one and two-year wood, at extreme right of picture, and also at outer end of one-year section at left.

shoots, and almost always a particularly abundant production just at the union of the one-year and two-year wood (Figs. 141, 142 and 143).

The method of bearing in the gooseberry is essentially the same as in the currant. There are two minor variations, however, which are worth keeping in mind in studying the bearing method and in doing the pruning. One is that the first class of canes mentioned, the straight, one-year growths, is much less abundant, and consequently a less important part of the bush;

and the other that the older canes continue to be useful much longer than with currants. This value of the older canes is due to the fact that they branch more freely and the branches retain their vigor and continue extending their growth much longer than do currants. Possibly a third difference is worth recording and that is that the gooseberry tends to make a much more dense growth from the much greater abundance of side shoots.

FIG. 144.—Currant grown in tree form. Not used commercially, but quite often seen in gardens.

It will be seen, therefore, that the bearing wood on these two fruits is constantly, and rather rapidly, getting away from the crown of the plant. The rate of this progression can be gauged by the length of the terminal growth on the main shoot and side branches. In practice it will be found that after three years the canes gradually lose their productiveness and the quality of the fruit produced gets poorer. Among our best growers, therefore, it is customary to have no canes older than three years.

When to Prune.—In regard to the time of year for pruning, it makes comparatively little difference. The principal thing to remember is that both these fruits start growth very early in the spring and that it is best to get the pruning done before growth has started at all. Late fall and very early spring are, all things considered, the best seasons for pruning, though occa-

sionally one finds a grower who prunes in late summer after growth is over. The one time when pruning should certainly not be done is just as growth is starting, since at that time one pulls off a lot of the expanding buds on the canes that are left when he is pulling out from among them the severed canes.

Number of Canes to Retain.—In commercial plantations it is customary to retain from four or five to eight or ten canes to a bush. Formerly there was considerable favor shown the single cane or low tree form with a short trunk and a number of main branches which were renewed from time to time as the canes of the bush form are, but the advent of the currant borer has pretty well driven this method out of use.

The Tree Form.—A type of bush which may still be found in amateur plantations but which has little but novelty to commend it is the extreme tree form shown in figure 144. This is secured by growing a single long stalk of some strong-growing species like *Ribes odoratum* to the desired height, say three feet, and then grafting onto this the desired variety.

Pruning Tools.—The only tool that will ordinarily be required for pruning the currant is a good pair of hand shears such as is shown in figure 165. In a very few cases the butts of the canes may get so heavy that long, two-handled shears like those shown in figure 99 or a small saw (Fig. 166) will be needed. For gooseberries the work will certainly be done more comfortably if the long-handled shears are used for taking out all canes.

The principal objects in pruning are the following: To keep the bushes from growing too high; to keep them open enough to let in plenty of light and air; to keep up a supply of new wood, and to get rid of the old wood that has passed its usefulness.

What to Prune Out.—The following outline may be found convenient in deciding what ought to be done:

1. Cut back the very vigorous, one-year shoots that come up from the crown or start from the tops of the younger canes. From one-fourth to one-third of their growth may be taken off to advantage.

2. Take out altogether the oldest canes. Generally all canes that are over three years old are removed.

3. Take out altogether any small, weak, one-year canes that have come up from the crown. Frequently there is quite a crop of these and they serve no useful purpose, merely thickening up the center of the bush and rarely bearing any fruit whatever.

4. Remove any very low-growing canes at the sides, such as are shown in figure 131. The fruit on these canes is seldom of the best, and as the fruit nears maturity and gets heavier the canes are sure to bend down to the ground during rain storms and the fruit get badly spattered with mud.

QUESTIONS

1. Describe the three types of wood usually found on a currant bush.
2. Where do you find the best fruit on a currant bush?
3. How does the gooseberry bear its fruit?
4. When would you prune these fruits? Why?
5. How would you prune a bearing currant bush?
6. What tools are needed for pruning these fruits?

CHAPTER XXVIII

DISEASES AND INSECTS OF THE CURRANT AND GOOSEBERRY

While, as in the case with the other small fruits, the list of insects and diseases attacking the currant and gooseberry is not as formidable as that of the apple or the pear, yet it is a sufficiently long list, and the pests are sufficiently serious to cause the grower of these fruits very serious losses. As is the case with most other fruits, and indeed most other economic plants, a very few insects and a very few diseases, not over two or three of each, stand out preëminent as dangers to be feared.

INSECTS

In a work of this kind it may be worth while to discuss only four insects, although Slingerland [1] describes at some length thirteen, and in addition mentions sixteen others which may attack these fruits.

Imported Currant Worm.—The list of insects may very properly be headed by the so-called "Imported Currant Worm," known to entomologists as *Pteronus ribesii*. Everyone who ever grew currants and gooseberries is thoroughly well acquainted with this insect, for it is very nearly omnipresent. The larval or "caterpillar" stage (which is the destructive stage) has a habit of beginning its attacks on the lower leaves where it is pretty well concealed, and then as the worms reach a larger size and develop a larger appetite suddenly appearing all over the bushes and completely stripping them of foliage in a very few days. Owing to this method of attack it is almost certain to get the start of one unless the spraying is kept in mind and an application is made very early in the season.

The life history of the insect is briefly as follows: The adult insect, which is known as a saw-fly, is yellowish and black in color and is about one-third of an inch in length. It appears

[1] "Manual of Fruit Insects," Slingerland and Crosby.

early in the spring, and the female deposits the long, cylindrical eggs in rows along the large veins on the under surface of the leaves and mostly on the lower leaves of the bushes. They hatch in a very few days; and the larvæ, which are greenish with black spots, at once begin their feeding and for some days work in groups. At first they merely eat holes in the leaves, but very soon they begin to eat the entire leaves except the main ribs, and in a surprisingly short time the bush is stripped. They pupate in trash about the bushes; and the adults, followed by a second brood of worms, usually appear about July 1st. The insect passes the winter in the pupa stage, these hibernating individuals coming from this second brood or sometimes from a third brood. Of course, if the first brood is entirely destroyed the trouble is usually ended for that plantation and that season. But by the next season adults usually come over from some neighboring plantation, so that the pest is with the grower every year for one brood at least.

Spraying early, shortly after the leaves appear, with arsenate of lead at the rate of one and one-half pounds of the dry form or three pounds of the paste to fifty gallons of water, is the most satisfactory remedy.

San José Scale.—The second insect pest, in point of seriousness, is the San José scale. It may easily head the list if one considers the permanence of the injury done, because if it is neglected the bushes may be killed outright in a single season or so badly injured that they are worthless. A factor which adds greatly to the seriousness of the case is the inconspicuousness of this insect. Often the first intimation that the owner has of any trouble is the poor growth that his bushes are making. On examination he finds them literally plastered with these little gray scales. They are difficult enough to see on any plant, but especially so on the gray bark of the currant and gooseberry. The insects breed continuously throughout the growing season, so that a comparatively light infestation in the spring may develop into a very serious one by autumn.

Spraying for Scale.—The only way to handle the pest satisfactorily is to spray the plantation every season in the early

spring with lime-sulfur, at the dormant strength, which is about one gallon of the concentrated solution to eight gallons of water.

Currant Borers.—Third in the list are the currant borers, which attack the canes of both these fruits, though they are more troublesome on the currant. There are two forms, one a small, dark blue moth, marked with yellow, which is by far the most serious, and the other a small brown beetle. But the work of the larvæ in the stems is almost identical and they may often be found in the same cane. The eggs are laid on the canes, and the little larvæ, on hatching, burrow into the center of the cane and there feed on the pith, sometimes making a burrow as much as a foot in length. In both cases the insect winters over in the pupa stage inside the cane, and emerges the following May or June. The canes which are thus attacked put out a sickly growth the following spring by which they may be identified. These canes should be cut out and destroyed before the adult insects emerge.

The Aphis.—The fourth insect is the aphis, which is almost certain to be found in the currant plantation. The eggs are black, very shiny, and are oblong in shape. They will be found on the new growth attached to the bark of the canes and hatch soon after the leaves appear, the young lice, which are yellowish green in color, crawling to the leaves and feeding on the under surface.

The insects which hatch from the eggs are wingless females, which very soon begin to produce other similar females. These are born alive and soon reproduce others, so that in a very short time the leaves are covered on the under surface. Later in the season winged females are produced which go to other plants, and still later both males and females. The latter deposit their eggs on the twigs to pass the winter. These hatch the following spring as already suggested.

Being a sucking insect, the feeding is done by puncturing the leaves and sucking the juices. This soon causes the leaves to begin to curl up and wrinkle until they are very greatly distorted (Fig. 145). Soon this wrinkled area begins to change to a yellowish and finally to a brownish or even a reddish color,

Leaves which are badly attacked usually fall, and in any case their function is so seriously interfered with that the fruit does not mature well. In addition, the fruit becomes coated by the honey-dew given off by the lice. This is later attacked by a fungus which turns it black, thereby injuring its appearance and sale.

Control of the Aphis.—The insect is difficult to control.

FIG. 145.—Leaves attacked by the currant aphis. Such leaves often become brown and fall.

Spraying with some contact poison, such as nicotine sulfate or soap solutions, is the most approved method of attack, but to be successful it must be done early and thoroughly, else the leaves will become so much curled that one cannot reach the insects with the spray.

Currant Maggots.—These are the larvæ of small flies (Epochra canadensis). They attack the fruits of all types of currants and occasionally infest gooseberries. In some western states these pests are so serious as to prevent the growth of

currants. The fruit is useless because of the maggots in them. The larvæ come to full growth as the berries mature. This causes the fruit to fall to the ground. The maggots form pupæ in the soil. The best remedy is to destroy the insects by some means. Remove the soil for several inches and spread it where swine or poultry can destroy the larvæ and pupæ. Hens scratching under the bushes will aid in destroying these pests.

DISEASES

Mildew.—Turning next to fungous diseases, we find the mildew by far the most serious of them all, particularly with the gooseberry. It is an American disease and doubtless for this reason the American varieties, as Downing and Pearl, are much less susceptible to its attacks. In fact, it is not usually a serious disease with them. On the other hand, the European varieties, as Industry and Crown Bob, are very seriously attacked, and the introduction of this disease into the European plantations has, in some cases, almost annihilated them. This, of course, is a very common phenomenon—a pest which is a comparatively insignificant one in its native habitat when introduced into a new country spreading with great rapidity and virulence. The disease is less troublesome in the North than in the South, as might be expected.

Character of the Attacks.—It is an interesting disease, scientifically, and to the man who does not own the plantation which is attacked. It attacks first the young, expanding shoots and leaves, spreading later to the growing fruit. The disease is mostly external, appearing at the beginning as small patches of threads closely woven together, forming a "cobwebby" appearance. These patches increase in size and may eventually run together forming large diseased areas. They also increase in thickness at the centers, forming quite a mat of threads, but spreading out at the edges into a very thin coating. Soon it begins to turn whitish from the production of the summer spores, known technically as conidial spores. These are produced in great numbers and help to spread the disease to other parts of the plant and to other plants. Later on the diseased areas turn

brown and in their centers the winter or asco-spores are developed which carry the disease over until the following spring.

The growth of the shoots, leaves and berries which are attacked is, of course, seriously interfered with or stopped altogether, and the fruits which are not so badly attacked as to be worthless as food are nevertheless so unsightly as to be entirely unsalable.

Control.—The disease can be fairly well controlled by thorough and repeated spraying. Potassium sulfide, or liver of sulfur, has proved to be the most efficient spray material for

FIG. 146.—Knapsack sprayer at work in currants and gooseberries. An excellent outfit for small plantations of these fruits, being convenient to use among the bushes.

this disease. The first application should be made just as the buds are well broken open, using it at the rate of one ounce to two gallons of water. From this time on applications should be made at intervals of from ten days to two weeks until three to six applications have been made, depending on the severity of the attack. Lime-sulfur has also proved reasonably satisfactory, applied at the rate of one gallon of the concentrate to fifty gallons of water (Fig. 146).

The currant and gooseberry leaf spot is another disease that is frequently a serious one, sometimes causing the leaves to turn yellow and fall, thereby seriously interfering with the health of the plants. It appears as rather large spots, brownish or grayish

in color, with a number of minute blackish specks developing later in the center of each spot. It is almost always present to a greater or less degree in the plantation, and nearly all varieties of both currants and gooseberries are attacked by it.

Bordeaux mixture is the most generally recommended fungicide for this disease. The first application should be given just as soon as the leaves are fully expanded, and it should be repeated at intervals of ten days to two weeks until two to six applications are made. Lime-sulfur at the same rate suggested for mildew is also promising and where it is successful its use, of course, simplifies the spraying program.

Anthracnose.—A closely allied disease in its manner of attack on the leaves is the anthracnose, though it also attacks the canes, the berries, and the fruit and leaf stalks. The disease usually appears first, or at least is noticed first, on the leaves, where it produces small brown spots which are round in outline and in the center of which a small black spot develops later. The leaves, if badly attacked, soon turn yellow and fall. Frequently the bushes are practically defoliated. On the stems and fruit the disease appears as small, black, sunken spots.

Varieties vary considerably in their degree of susceptibility and the currant is more likely to be attacked than the gooseberry.

Remedies.—The most satisfactory remedies are Bordeaux mixture and lime-sulfur, the latter at the rate of one gallon to forty gallons of water. The first application should be made as the leaves are appearing, and after that at periods of about two weeks until four to six applications have been made. In sections where the disease is especially troublesome, or in seasons when it has been very plentiful, it may be best to make one spraying after the fruit is harvested.

Cane blight is one of those diseases for which no entirely satisfactory remedy has been worked out. The first evidence of its presence is a wilting of the leaves on one or more canes, or perhaps on only certain branches of the canes. Later the entire cane may die and perhaps eventually the whole bush. The fungus causing this disease works in the bark, wood, and pith, causing the death of a section of the stem. This, of course, cuts off the movement of sap up the cane; all those parts above

this girdle of dead tissues are killed, the leaves wilting and eventually dying. It is usually possible on splitting open the cane at this diseased point to detect the whitish threads of the fungus.

The only remedy suggested is cutting out the diseased canes, and this ought always to be done. But even with the utmost care in this regard it is not usually possible to completely eradicate the disease, and it gradually weakens the bushes and reduces the yields until the plantation has to be abandoned.

Pine Blister Rust.—A last fungous disease which ought to be mentioned, not so much for its direct injury to the plantation as for its indirect, is the pine blister rust.

This is one of those curious fungous plants which passes a part of its life cycle on one plant and a part on another. In this case it is the white pine, on the one hand, and the currant and gooseberry on the other. It is considered a very serious disease on the pine, and in sections where this tree is important a move has been made to pull out and destroy all affected currant and gooseberry plants, and new bushes should not be planted. It is too soon to say just how serious the disease may be on these fruits, but the destruction of them to save the pines is certainly a serious matter. The spread of the disease among white pines may greatly limit the planting of currants and gooseberries.

QUESTIONS

1. How do the diseases of the currant compare with those of the apple?
2. Describe the currant worm. How would you fight it?
3. Did you ever see a currant bush killed by the San José scale? Describe this scale.
4. How would you make sure that the San José scale didn't injure your currant plantation?
5. Describe the currant borer and tell how to control it.
6. Describe the work of the aphis on currants.
7. Discuss the mildew of these fruits.
8. What does the currant leaf-spot look like? How would you control it?
9. Describe the anthracnose of these fruits.
10. What is the most serious insect attacking these fruits in your section? Have you seen it at work? What ought to be done to best control it?
11. Is the white-pine blister rust common in your section? How is it related to currant growing?

CHAPTER XXIX

HARVESTING AND MARKETING CURRANTS AND GOOSEBERRIES

These subjects must be discussed separately, since the methods in vogue for gooseberries are quite different from those in use with currants.

Degree of Ripeness of Currants.—Like most other fruits, the degree of ripeness which is desirable with the currant varies with the distance to market and with the uses to which it is to be put. For distant markets, when the fruit is to be shipped by express, it should be picked while the berries are still firm, and some may even be so unripe as to be greenish in color. For nearby markets a considerably greater degree of ripeness is allowable and even desirable. There is a very strong prejudice with most housewives, in favor of decidedly unripe currants for making jelly, because they jell better and because the jelly is lighter in color and clearer. It is quite a question with the writer whether this prejudice is warranted. If quality and not appearance is the test, probably nine people out of ten would vote for the jelly made from ripe currants.

In the operation of picking the currant two things ought to be insisted on if the fruit is to land on the market in good condition. In the first place, the stems should always be picked with the berries and not left attached to the bushes. Berries which are pulled off the stems are of little value except for very nearby markets to which they can be sent immediately, and where they will be used at once.

In the second place, great care should be taken not to crush the berries, for even when the picker does not pull them off the stems he often bruises them so that they will very quickly spoil. Moreover, the loss is not confined to the berries so bruised, but a few such berries in a box will start trouble and very soon the whole box is ruined.

To be sure that these two conditions are observed by the

pickers requires constant watchfulness on the part of the foreman. The boxes must be frequently examined as brought in by the pickers and any loose or bruised berries called to the attention of the delinquent picker (Fig. 147). The rules are easier to observe with some varieties than with others, owing to the difference in the length of stems in the clusters. Where the stem is long it is easy for the picker to get hold of it without bruising the berries; where it is very short, as it is with some varieties, it is much more difficult.

FIG. 147.—Pickers at work in currant plantation. A few women in the gang will steady the work of the whole force.

It is also imperative that the fruit be dry when picked and packed, otherwise it is almost certain to spoil in transit. Of course, a combination of wet and bruised berries is the worst one possible.

Picking Gooseberries.—In the picking of gooseberries the case is quite different. The fruit is naturally very firm and is usually picked while quite green and hard, so that there is very little danger of its being bruised in handling. But the thorny nature of the bushes makes the picking a very unpleasant task for the operator, so that everything possible ought to be done to

protect him. To begin with, the bushes ought to be pruned, so that they may be kept as open as possible to allow room for getting at the fruit. Then it is usually best to have the pickers wear gloves, heavy leather ones being best, so that the hands may be protected. Even under the best of conditions, however, it is not a popular kind of work.

With the rough handling that is almost unavoidable in picking gooseberries, a great many leaves will be stripped off with the fruit, and it is a common practice on commercial plantations to run the berries through an ordinary fanning mill in order to get out the leaves and trash.

Green or Ripe Gooseberries.—It might be said in passing that the practice of picking gooseberries so long before they are ripe is a questionable one. It is not a very popular fruit at best, and it is quite a question whether it will increase much in popularity so long as this practice of picking it while still decidedly unripe is continued. One might as well expect to pick a McIntosh apple in August, and have his customers enthuse over its quality, as to sell green gooseberries and have the consumer anxious to get more. When fully ripe, gooseberries are really very delicious, especially the large English varieties, and while it will cost more to handle them when ripe, owing to the greater care necessary, yet this practice probably offers the most hopeful field to the man who really wants to popularize the gooseberry. The only serious objection to allowing gooseberries to become ripe before they are picked is the fact that the seeds become hard and woody. This is a more serious objection with some consumers than with others, however, and those who are really fond of gooseberries will put up with it for the sake of the better flavor secured.

Baskets and Crates.—For local markets, or for any trade in these two fruits where they are to be used by the housewife, they are usually handled either in the ordinary quart baskets, as other berries are, or else in the climax grape basket. The quart baskets are packed in crates, the thirty-two-quart size being the most popular (Fig. 79), though smaller and larger crates are sometimes used. If the grape baskets are used the nine and ten-

pound sizes are the most popular and, in fact, have much to commend them from the standpoint of both producer and consumer.

When the fruit is to go to factories it is generally handled in larger packages, nothing smaller than climax baskets being used, and very frequently half bushel and even bushel boxes. Of course, gooseberries, owing to their firmer texture, can be handled in somewhat larger packages than currants.

USES

Currants are used most largely for jellies; in fact, this is the only use to which they are put in the average household. For this purpose, as already suggested, most housewives prefer that the currants should be decidedly unripe, thinking that they will not jell well when ripe. As a matter of fact, they will jell in a perfectly satisfactory manner so long as they are not overripe, and the quality of the jelly will improve very decidedly as the currants pass from the unripe to the perfectly ripe stage. Moreover, the currants are, of course, more attractive when they are ripe, on account of the better color. If consumers could be educated up to the point of appreciating that ripe currants will jell satisfactorily it would undoubtedly help the trade in this fruit.

Pies and Sauce.—In addition to being used for jelly making, currants are occasionally used in their season for pies and sauce, or are canned for winter use.

As Ripe Fruit.—Another use to which they are occasionally put, and which ought to be more general, is as a dessert fruit in the fresh condition. Some of the milder-flavored varieties, as the Perfection among reds, and the White Grape among whites, are especially to be commended for this purpose. They will hang on the bushes for a long time and hold their quality remarkably, in fact, improving in quality for many days after the commercial harvesting is over. This is a use of the fruit which is worthy of encouragement by progressive growers as there is no reason why a continuous market for ripe currants in limited quantities might not be developed in any local market if consumers could be educated to an appreciation of them. Of

course, they are decidedly tart and they are seedy, but the former characteristic is refreshing and one becomes accustomed to the latter.

Spiced Currants.—One other use for currants ought to be urged by the grower who is trying to develop his market to the greatest extent, and this is as spiced currants to be eaten with meats. They certainly are delicious and will appeal to most people once they are introduced.

Gooseberries are much less commonly used than are currants; in fact, the demand in any locality is strictly limited. The percentage of them which is used in the household, as compared with those used in factories is much less. Consumers seem much more inclined to buy their gooseberries already put up than they are their currants.

And yet if properly handled in picking and in canning and preserving, the gooseberry is a really delicious fruit. Its most popular end seems to be as a preserve, yet it makes a delicious jelly, it may be canned for future use, and gooseberry pies are very popular where they are known, coming, as they do, in the early part of the fruit season, while our appetites for new fruits are still keen.

QUESTIONS

1. How ripe should currants be when picked?
2. Describe the operation of picking currants.
3. What is the best way to pick gooseberries?
4. How ripe should gooseberries be allowed to become before they are picked?
5. What type of crate is most commonly used for currants and gooseberries?
6. What baskets are used?
7. What are the principal ways in which currants are used?
8. How are gooseberries used?

GRAPES

CHAPTER XXX

SITES AND SOILS FOR THE VINEYARD

The most important single question to consider in the selection of the site for a vineyard, and the most important single factor in bringing certain regions into prominence as grape-growing sections, is temperature. Other matters, such as soils, rainfall, and fertilizers, are all of them important, and many of them extremely so, but they are none of them as vital as temperature. The yield from a vineyard may suffer because the soil is not just the right type, or because it lacks fertility, but if the temperature in the vineyard drops low enough on a single night to give a heavy frost the whole crop may be a total loss.

Best Temperatures.—It is desirable to have an even temperature for the growing season, since sudden and extreme changes are likely to affect the grape unfavorably. It has been shown that an average mean temperature of 55 degrees for April, May, and June, which are the months during which the grape makes its most rapid growth, and a mean temperature of 65 degrees for the maturing months of July, August, and September, are likely to give the most satisfactory conditions for regular and abundant crops.

Factors that Affect the Temperature. Latitude.—The first and most important factor influencing temperature is, of course, latitude; and this is one reason why we find the great grape-growing regions of the country centered in New York, Pennsylvania and Ohio.

Altitude.—Next to this would stand altitude, both general and local. An elevated section gets a lower mean temperature than a low-lying region in the same latitude; while local elevations, if they are not too extreme, give the site immunity from frost, which is, of course, an extremely important matter. This immunity from frosts is brought about by the atmospheric drainage which such a location gives, the cold air draining away to the lower levels, and it is surprising what a slight slope is necessary to thus drain away the cold air.

Lakes and Rivers.—Another extremely important factor in determining the temperature of a section is the influence of lakes and rivers. This influence is always on the side of reducing danger from frosts. In the spring the water tends to keep the air cooler, and consequently the vines are less likely to start into growth until danger from frosts is past; and in the autumn the water keeps the air warmer and so prevents the occurrence of frosts until long after they have occurred in other sections of the same latitude but which are unaffected by the lake or river. In almost all cases, therefore, it may be said that the influence of lakes and rivers is in the right direction; they are strictly beneficial. The only exception would be in the case of very large lakes which sometimes so prolong the growing season of the vineyard that the fruit does not mature well.

The effect of rivers is, of course, far less pronounced than that of lakes, yet it is often surprising how much influence a stream will have upon frosts. This influence is exerted in two ways. In the first place, the cold air of adjoining fields tends to drain into the river and be carried away. And in the second place the water of the stream tends to make the surrounding air more moist as well as warmer in the autumn, and so prevent the occurrence of frosts on nearby fields, when they may be severe on lands beyond the influence of the river.

Winds are also important in their influence upon temperature as well as in several other ways. As a rule, winds are not beneficial to vineyards. They dry out the soil, injure the vines, damage the fruit, and break down the trellis. The principal exception to this rule is their effect on fungous diseases, and in some sections winds are credited, and no doubt properly so, with assisting very decidedly in keeping in check the diseases of the vineyard by keeping the foliage dry so that disease germs do not as readily germinate, and the air reasonably dry so that it is not as favorable to the development of the fungus after it has started to grow.

Exposure and Slope.—A last factor which influences temperature is the exposure of the vineyard. Many growers prefer a southern or southeastern exposure, largely on account of the higher mean temperature, though it may have other advantages,

and the importance of this point increases as one gets farther north. It may be possible to bring grapes to perfect maturity and fine quality in a sheltered location with a sharp southern exposure, while on immediately adjoining lands without these advantages they cannot be grown with any degree of success.

Of course, the objection to a steep slope is that it increases so seriously the damage from the washing of the soil, and usually this single objection is sufficient reason for not selecting such a site for a commercial vineyard. This would not be serious, however, for a small home vineyard, and such a site is often selected. As one approaches the northern limit of successful grape culture, the foregoing considerations become more and more important, while as one goes farther south they become less important, until one reaches a point where high elevations are desirable because they are cooler, and where northern rather than southern exposures may be preferred.

The ideal location (Fig. 148) for the vineyard would therefore be on gently rolling lands, as a rule, except where there is a very decided influence from a lake.

Soils for Grapes.—Turning now to a consideration of soils, we find that many types may be used successfully if they are handled in the best manner, and if the right varieties are selected for each particular soil.

As a general rule, warm soils with some gravel in them are desirable, because soil heat is almost as important as the heat of the air in promoting the growth of the vines and in hastening the maturity of the fruit. With this idea in mind, therefore, as the chief consideration, one would select sandy or gravelly loams, and a considerable amount of stone and shale might even be admitted as tending to increase soil temperatures. On such soils one would be most certain of being able to mature his crop of fruit, and if the soil were fertile as well as warm, the maximum crops of fruit could probably be produced.

Factors Affecting Soil Temperatures.—In addition to the natural character of the soil (whether clay, silt, or sand) the temperature of the soil may be influenced in many ways, the principal ones being the following:

1. *Drainage.*—This is the most important single factor out-

FIG. 148.—A good vineyard country. Such rolling land gives good atmospheric drainage and warm slopes on which the fruit ripens well.

side of the natural type of the soil. In some cases it may even exert a greater influence than the type of soil. One cannot expect to have a warm soil if it is a wet one, as the two do not go together. It takes five times as much heat to raise a certain bulk of water ten degrees in temperature as it does an equal amount of sand. And there are many other things besides soil temperature which make a wet soil objectionable. The grape simply will not succeed on such a soil. One should therefore drain the land if it is wet, or else abandon the site and plant elsewhere.

If the land is to be drained the most effective way is to use tile. While this is expensive it is generally to be recommended, as the improvement of the soil is then permanent. Of course, something may be done by open ditches, and sometimes they may be necessary to carry off surface water, even though the land is tile-drained. But ditches are never very effective so far as their influence on the water in the soil is concerned, and, moreover, they are in the way and take up valuable room, so that tile draining is much to be preferred.

2. *Add Humus.*—Incorporate as much humus in the soil as possible. This renders it lighter and more friable, admitting the air more freely and thereby renders it warmer, as well as improving it in many other ways.

3. *Practice Good Cultivation.*—Deep plowing and even subsoiling of the land before the vineyard is set, and reasonably deep plowing with good cultivation after it is set, will have a very decided influence on the temperature of the soil.

Of course, the farther north the grower is located, or the longer the season needed to mature the variety grown, the greater would be the importance of a warm soil and the more one should insist on the types just discussed.

Influence of Heavy Soils.—On the other hand, there is much evidence to show that some of the heavier soils, the silty loams, clay loams, and even the fairly heavy clays, while they do not ordinarily produce as large crops as the lighter and warmer soils, and while they are not so certain to mature their crops, frosts occurring in the autumn before the fruit is ripe, yet the quality of the fruit produced is very much better. It is sweeter,

has more of a bouquet, and its keeping quality is very much improved. This being the case the question arises whether it might not be possible in many cases to so handle these clay soils as to overcome their bad influences on the vineyard, and particularly on the size of crop produced, and perhaps on the date at which it matures. This would mean making them lighter and better drained, and the three points just discussed (drainage, incorporation of humus, and good culture) would be the most hopeful lines along which to work.

Soil Fertility.—While a high degree of fertility is not necessary for the vineyard, and while too great fertility is even to be avoided, since it tends to give more wood growth and less fruit, yet the question of the natural fertility ought always to be considered in selecting the vineyard site, and this is certainly one reason why clays give better results than sandy soils as just suggested.

If the fertility is not in the soil naturally, or if the physical condition is not as good as it should be, it is very desirable to take a year or so before setting the vineyard and get the soil into better condition. Efforts in this direction would be along the lines (1) of growing cultivated crops on the land; (2) of incorporating humus in the soil, and (3) on the heavier types of soils, or on those which are strongly acid, of applying lime. This latter is not often done, but there is little doubt that it might be frequently used to advantage. Two tons of ground limestone per acre, or half that amount of burned lime, if the soil is especially heavy, will correct the acidity and greatly improve the physical condition of the soil.

QUESTIONS

1. Why is temperature so important a factor in grape growing?
2. What are the best temperatures?
3. How do latitude and altitude influence temperature?
4. How do lakes and rivers influence temperature?
5. How do winds affect vineyards?
6. What exposure or slope is best for a vineyard site? Why?
7. What is the best type of soil for a vineyard?
8. What factors influence soil temperatures?
9. What advantages have heavy soils for grapes?
10. Discuss soil fertility in vineyards.

CHAPTER XXXI

VARIETIES OF GRAPES

No group of fruits is more interesting botanically, and perhaps none is more complicated, than the grape. It is not the province of a work of this kind to discuss this question at any length, yet it has such an important bearing on the characteristics of varieties, and on the very practical matter of selecting varieties for the vineyard, that a brief discussion is advisable.

Species of Grapes.—The most important single species of grape which is involved in the production of the varieties grown in the United States is undoubtedly the northern fox grape, *Vitis labrusca,* one of the native species of the northern and eastern sections of this country. The fact that this species has to its credit the Concord would in itself fairly well establish this claim; but it has also produced such varieties as Eaton, Moore's Early, and Worden.

The wild species gets its name from a peculiar musky odor and flavor of the fruit, and when this is carried by the cultivated offspring it is always to be regarded as a handicap in a commercial variety, and except for the comparatively few people who think this flavor is pleasant and refreshing, it is an even more serious objection from the standpoint of the home vineyard. With some of the cultivated varieties of this species, Dracut Amber, for example, the characteristic is almost as strong as with the worst of the wild forms, and in such cases they have not become very popular, even though they may have had many other excellent qualities.

European Grape.—Probably the second most important species of *Vitis,* so far as its influence on the vineyard industry of the United States is concerned, is the European grape, *Vitis vinifera.* This is not only important in itself in such sections as southern California, but it has entered into the production of many hybrids, such as Delaware, Catawba, Brighton, and Niagara, which are very important commercial varieties in

most of the leading grape-growing sections of the United States and Canada.

Summer Grape.—A third species which has had a considerable influence in the production of American varieties of grapes is *Vitis æstivalis,* a more southern species, ranging generally from Virginia southward, and known popularly as the Summer Grape. This species has been involved mostly in the production of varieties used for wine making, such as Cynthiana and Norton, but is also considered by some to have entered into the production of such sorts as Winchell, or Green Mountain, which is distinctly a table grape. The fruit of the wild forms, and to a large extent of cultivated varieties derived from it, has usually a distinctly sprightly flavor and is apt to be pretty acid, too much so for table purposes. But it carries plenty of sugar, and some of these varieties are among the most popular wine grapes. The vines are resistant to the attacks of both diseases and insects, including the phylloxera, but most of them require a comparatively long season in which to mature their fruit.

Vitis riparia, the River Grape, is another species that has had much the same type of influence on the grape industry of the country as has *æstivalis.* The vines are vigorous, are very resistant to phylloxera. The cuttings root readily, and its most notable contribution to the vineyard industry of the world is its use as a stock for the *vinifera* varieties, particularly in the vineyards of Europe. The fruit of the species is small, and even when hybridized with *labrusca,* in such varieties as Bacchus and Clinton, no great size is produced. There is a very distinct acidity to the fruit even with the hybrids, at least, until they become very ripe indeed. Another serious drawback to the varieties derived from this species is their susceptibility to the attacks of leaf hoppers which are especially partial to them and often very seriously injure the foliage of such varieties.

Two other species or botanical varieties, *Vitis æstivalis Bourquiniana* and *V. æstivalis Lincecumii,* have been brought into prominence through the work of Mr. T. V. Munson, of Texas, and varieties derived from them are important in that section of the country.

Muscadine grapes belong to the species *Vitis rotundifolia.* They are represented by James, Scuppernong, and many other varieties of several colors. They are very commonly grown in the southern and southeastern states. The plants are resistant to disease, and are very vigorous growers. The fruit is borne in small clusters and the berries fall badly.

Variety Characteristics.—Turning now to a consideration of some of the important characteristics of individual varieties (a list of the characteristics of the ideal variety, so to speak), we have the following points which are all worth taking into account, though some are far more important than others.

1. **Productiveness.**—This needs little or no discussion. No one would question its importance. It is important whether one is growing grapes for money or for fun; there is neither money nor fun in grapeless grape vines. Yet it is, of course, far more important with the commercial grower. Productiveness is responsible for a large part of the popularity of certain varieties which are poor in quality but produce so much fruit that they are profitable even at a lower price.

2. **Quality.**—This probably stands next to productiveness in importance for commercial vineyards, and ahead of it for the home vineyard. If one wants to get an idea of how great the difference in quality is between a really fine variety and a decidedly poor one, let him compare Champion or Ives or Dracut Amber with Delaware or Brighton or Diamond. Good grapes are so delicious in flavor that it seems peculiarly unfortunate and even inexcusable to leave this factor out of consideration in choosing varieties. Usually the quality of a variety is improved by the infusion of some *vinifera* blood; there is less likely to be a foxy taint to it, and more sure to be plenty of sugar and that vinous character which is so attractive.

3. **Resistance to Disease.**—This is a point of great practical value, especially to the commercial vineyardist, but it is no small consideration to the home gardener. And there is a wide difference in various sorts in this respect. One variety is always troubled with mildew and another very seldom has it; one variety is completely ruined by black rot while another is com-

paratively immune. Generally *vinifera* blood lowers the standing of a variety in this respect. *Æstivalis* varieties are highly resistant to disease. The muscadine group is seldom affected with disease.

4. **Color.**—We have, of course, the three general classes of colors, red, white, and black; and the point to consider here is not so much a difference in the attractiveness of two red varieties, though there are decided differences, as it is to select some sorts of each color in order to have a pleasing diversity of colors. This is a point of practical importance in catering to a local trade, assisting the grower in pleasing customers, and helping to prevent gluts, and it certainly adds greatly to the charm of the home vineyard if one has all three colors (and several different shades of each color) represented.

5. **Self-sterility.**—Many varieties of grapes are almost entirely self-sterile; that is, they cannot fertilize themselves, while others are said to be entirely self-fertile. It is not necessary to discard a variety because it is self-sterile, though it is usually considered as a point against it, but the characteristic ought to be known and considered, so that other varieties may be set with it. Even with those sorts which are rated as self-fertile it is probable that cross-pollinating helps to make their crops more sure and abundant. Muscadines are mostly diœcious, and male vines are grown near the fruiting ones.

6. **Does It Shell?**—Do the berries separate readily from the stems? Some varieties are much worse in this respect than others. As a class, the *labruscas* shell very badly, while the *viniferas* do not; and any infusion of *vinifera* blood is apt to help in preventing the shelling of a variety; that is, the *labrusca-vinifera* hybrids do not shell nearly so badly as do the straight *labruscas*. Muscadine varieties shell still more seriously and are, therefore, not popular as market grapes. This point is, of course, especially important with commercial growers, but it is worth consideration even for the home vineyard.

7. **Does the Variety Keep Well?**—This is another point which is especially important for the commercial grower, but, like shelling, is worth consideration by the amateur. And there

is a marked difference in varieties in their ability to stand up after they are ripe.

8. **Type of Bunch.**—This is a point which is especially important with the commercial grower, since a handsome bunch will sell better than an ugly one, yet even for the amateur the pleasure of growing a really beautiful bunch is worth consideration. Of course, it may happen that other good points in a commercial variety more than offset the value of a handsome bunch, but, other things being equal, or nearly so, the variety with the handsome bunch is the one to choose.

Ideals differ, of course, but with the writer the ideal bunch of grapes should be somewhat as follows: It should have a shoulder and should be reasonably compact, though not too much so. Extremely compact bunches are not apt to develop all their berries so well and they are not so comfortable to handle in eating. It should taper to a point like the Brighton instead of having a blunt end like Champion or Eaton. All parts should be well developed, with the berries uniformly ripened and no diseased, small, or poorly developed berries. Lastly, it should have a handsome bloom and it should be grown and handled so that the bloom is not blemished.

9. **Resistance to Phylloxera.**—This character is not possessed at all, or to a very small degree, by the European sorts; but even among our American varieties there is a wide difference in the degree of resistance to this pest. Those of the *riparia, rupestris, and æstivalis* groups are most resistant to phylloxera.

Leading Varieties.—While different sections have their preferences as to varieties, yet it is surprising how widely certain varieties are grown. And it would surprise any one who has not studied the matter to see how nearly identical the lists would be if one compiled a catalog of the six or eight leading varieties in the principal vineyard sections of the country.

It may, perhaps, be in order under these circumstances to describe very briefly a few of these leading varieties.

Concord.—The list should, of course, be headed by the Concord (Fig. 149), which is the back-bone of the vineyard in-

dustry of most grape-growing sections of this continent, just as the Baldwin apple is the back-bone of the apple orchards of New York and New England. The California region is a notable exception to this. While Concord is grown there for grape juice

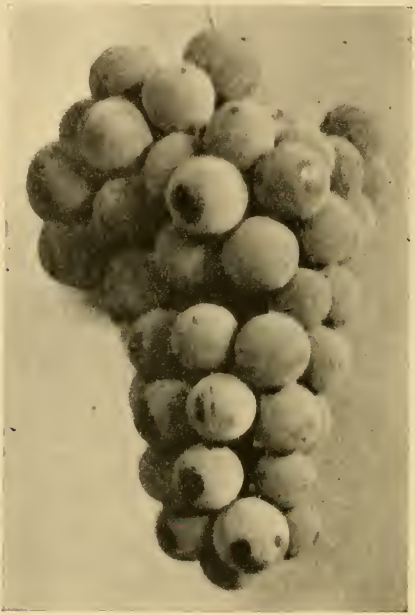

FIG. 149.—A cluster of Concord grapes, the most noted variety of American grapes and one which succeeds over a wider range of country than any other variety.

and table use, the raisins and wine grapes of the *vinifera* group predominate.

The Concord was grown from seed of a wild grape planted by Ephraim W. Bull, of Concord, Massachusetts, in 1843. It is a rather handsome and fairly large black grape, ripening about mid-season. Its quality is not of the best, as it carries some of the foxy flavor of its wild ancestors and is not so rich

and sweet as many other varieties, and yet it is by no means a poor grape for table use. Its most valuable characteristic is perhaps its ability to succeed on a wide variety of soils. It will do reasonably well on all of the different types of soils consid-

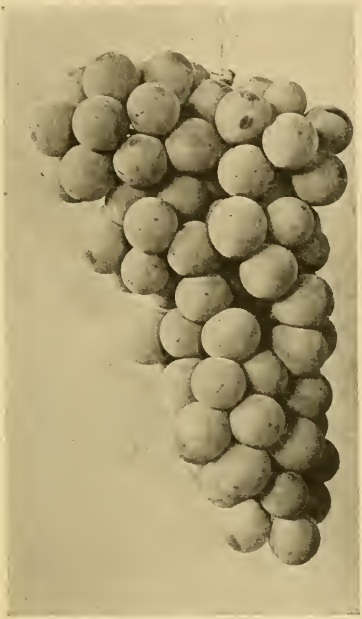

Fig. 150.—A cluster of Niagara grapes, a white variety and one of the most beautiful grown. It is of good quality and succeeds well in most sections.

ered as grape soils, and remarkably well on most of them. It is also very productive. This combination of characteristics makes it reasonably sure that the grower, whether he grows it for money or for his own table, will each year harvest a large crop of fruit which looks good and tastes good. It is this certainty of results which "takes" with the average grower.

Niagara.—Next to the Concord would probably stand the Niagara (Fig. 150), though opinions might differ on this. It is a seedling of the Concord, said to have been crossed with pollen of Cassady, a *labrusca-vinifera* hybrid. It carries some of the Concord's good characters. Its two most valuable characteristics are its productiveness and its beauty. The clusters are large and well formed, and the berries large and handsome; in color a yellowish green when fully ripe. A well-grown bunch of Niagara is certainly a thing to admire, and many people will be equally enthusiastic after they have eaten it, though the really critical will find much to be desired in the flavor. It is not quite so hardy as the Concord and is much more susceptible to diseases. It is not a variety that the writer would set in his own home vineyard, but its good points will always make it popular as a market sort.

The Delaware (Fig. 151) is another very popular market grape, and is almost equally desirable for home use. Its history is very obscure, and authorities can only guess at where and how it was originated. It is thought to be a hybrid containing the blood of three species, *labrusca, vinifera,* and *Bourguiniana.* Both in bunch and berry the Delaware is small in size, and this constitutes its most serious shortcoming. It is also rather a poor grower, with a decided tendency to overbear. These characteristics, combined with the small size of its bunches and berries, make it necessary to feed and cultivate it well and to prune it severely if reasonably satisfactory clusters are to be secured. But its extremely high quality, its hardiness, its productiveness, and its resistance to many insects and diseases make it a favorite with both the amateur and professional grower.

The Worden is a seedling of the Concord and is considered as a straight *labrusca;* that is, the seed from which it grew was either a self-pollinated one or the pollen came from some other *labrusca vine.* It is a large and handsome black variety, both bunches and berries being larger than those of the Concord. It ripens a week or ten days earlier than Concord, which makes it valuable for those sections where there is doubt about ripening

Concord before frost. In quality, Worden is generally considered to be decidedly better than Concord, and it is therefore usually preferred to it as a home grape. It is much softer than Concord, and therefore does not stand up so well when shipped and it is more liable to crack. These characteristics are its chief shortcomings as a market sort, but they are sufficiently serious to considerably reduce its popularity as a market variety except

FIG. 151.—A cluster of Delaware grapes. This is a very popular variety for both home and market use.

where it is to be sold locally. When used locally, however, either grown in the home vineyard or for local market, it is very popular and deservedly so.

The Brighton (Fig. 152) is a hybrid between the two species *labrusca* and *vinifera,* having been produced by crossing the Concord and the Diana Hamburg, the latter itself being a *labrusca-vinifera* hybrid. The Brighton is thus what is known as a secondary hybrid. It is a very handsome grape, of a deep red color, and with particularly handsome clusters. The quality is especially good, with a rich, vinous, sugary flavor that always

makes it a favorite. As a variety for the home vineyard, or for local markets, the Brighton is very deservedly popular. It does not stand up well in shipping and marketing, however, the fruit deteriorating in quality very quickly, so that it is not

FIG. 152.—A cluster of Brighton grapes, one of the finest varieties for home use or local markets.

generally popular for distant markets. Another defect which it has and which should always be provided against by setting it along with other varieties, is its tendency to self-sterility. In this respect it is one of the most serious offenders.

Moore, or Moore Early, is an early black grape, a seedling of the Concord and therefore another straight *labrusca*. It re-

sembles the Concord in many ways, but ripens earlier and the clusters are not so large nor so handsome. Its quality is only fair, and, like all *labruscas,* the berries shell badly. But as an early variety to extend the season it is deservedly popular both for market and home use.

Catawba.—In many grape-growing sections Catawba is ranked among the three or four most important varieties. Its origin is not known, but it seems certain that botanically it is a hybrid between *labrusca* and *vinifera.* It was introduced by John Adlum, of the District of Columbia, in 1823, and has been popular ever since. It is a handsome red grape with very compact clusters, fine quality, and remarkable keeping quality. It is decidedly subject to fungous diseases, which is, of course, a very serious handicap, and its very late season of ripening makes it unsuited to sections where early frosts occur. But having stood the test of nearly a century it is likely to be some years yet before it is supplanted.

Winchell or Green Mountain, while not grown very largely in commercial vineyards, deserves mention here as an early variety to lengthen the season of marketing or home use. It is certainly one of the very best early grapes as to quality, and has many other characteristics to commend it, being hardy, vigorous, and productive. It was originated by James W. Clough, of Stamford, Vermont, from seed of an unknown variety, but it is generally considered to be a hybrid of at least the two species *labrusca* and *vinifera,* and perhaps has blood of *æstivalis* as well. Some authorities regard the Winchell and Green Mountain as two distinct varieties, but it is usually considered that they are one and the same variety. At least they are very nearly identical.

Campbell or Campbell's Early is one of the latest varieties to come into popular favor and commercially has had a somewhat checkered career. It was very popular when first introduced, but owing, perhaps, to its not being grown on the right type of soil, or to some other mismanagement, it has often proved disappointing. It is a large and handsome black grape, ripening ten days or two weeks before Concord. It is a *vinifera-*

labrusca hybrid originated by G. W. Campbell, of Delaware, Ohio. One of its parents was a seedling of Moore, and the other parent another seedling produced by Mr. Campbell, using pollen from Muscat Hamburg which thus introduced the *vinifera* blood. Its quality is excellent when allowed to get fully ripe, and it is a very valuable addition to the list of early varieties.

Other Good Grapes.—In addition to the foregoing varieties the following list is worthy of consideration by the amateur who is fond of good grapes:

Agawam, red	Herbert, black
Barry, black	Iona, red
Brilliant, red	Lady Washington, white
Diamond, white	Lindley, red
Dutchess, white	Merrimac, black
Gærtner, red	Triumph, white
Gœthe, red	Wilder, black

California Varieties.—In the region centering about southern California, varieties of the species *Vitis vinifera* of Europe are largely grown. The old Mission variety is often called El Paso, California, and other local names. This is being, or has been, replaced by the Flame Tokay for shipping, the Muscat of Alexandria for raisins, and perhaps the Zinfandel for wine. Numerous minor varieties supplement these. As these *vinifera* varieties are subject to attack of phylloxera they are grown on resistant stocks of the river grape (*riparia*) and the sand grape (*rupestris*).

Muscadine varieties are grown mostly for home use and for commercial manufacture of marmalade, juices, etc. Their tendency to fall from the stem makes them unsuited to shipment for table use. The Scuppernong is the oldest variety. Others are: Memory, Thomas, James, Luola, Flowers, and Mish.

QUESTIONS

1. Name the wild species of grapes that have been used in developing our cultivated varieties.
2. Which two of these have had the most important influence on the grapes of the United States?
3. What wild species of grapes grow in your region?

4. Give a list of the important characteristics of a market variety of grapes. Which two of these do you think are the most important?
5. Discuss the Concord grape.
6. What is the most important variety of grape in your section? From what wild species was it derived?
7. Describe the Delaware grape.
8. Give a list of the five varieties of grapes that you would set in a home garden.

CHAPTER XXXII

ESTABLISHING THE VINEYARD

While the propagation of grapes is usually a separate business, carried on by the nurseryman and not by the grower, yet it may be worth while to include here a brief discussion of the subject.

Grapes are propagated most commonly by ordinary, hardwood cuttings, but single-eye cuttings, layering and grafting are also used.

In propagating by cuttings only the wood of last season's growth should be used, and care should be taken not to use the wood from the tips of canes where it has not ripened well. It is also best to avoid very rank canes which have made a heavy, long-jointed growth. This is because such wood contains fewer buds in the length of each cutting, and the wood itself is coarse-grained and apt to be less well supplied with stored foods. Buds are desirable not only to furnish the growing point which shall produce the shoot from the upper end of the cutting, but also because their tissues are better supplied with elaborated plant foods, such as starch, and consequently roots will push out more vigorously from near the buds on the lower part of the cutting.

The wood is cut into lengths of perhaps six to eighteen inches. The length of cutting depends partly on the type of wood used, being longer, as a rule, where one is forced to use very long-jointed wood. Longer cuttings are also used in sections where the season and the soil are apt to be dry. In this latter case the cutting must be long enough, so that its lower end may be buried in the soil to a sufficient depth to insure the surrounding soil being moist. It is best to cut fairly close to a bud at the lower end of the cutting, since this lower end is the point where the roots are most likely to start and the bud insures a good growth of roots. At the upper end it is customary to cut about an inch above the last bud. This is to allow some drying out and

dying back of the tip of the cutting without injuring and weakening the bud.

Storage of Cuttings.—The cuttings may be made at any time after the leaves have fallen from the vines in the autumn. This is best done fairly soon thereafter to avoid all danger of the wood being injured by cold weather, and to allow plenty of time for the cuttings to callous. They are tied up in bundles of twenty-five or fifty. Care should be taken to see that the butts of the cuttings are all at one end of the bundle, since it is to be buried with the butt end of the cuttings uppermost. A warm, well-drained spot should be selected for this purpose and the bundles buried so that the upper end is about four or five inches below the surface of the ground. Here they are allowed to remain, usually until spring, and the butt ends of the cuttings, being in the warmer soil, form a callous and begin to start roots, while the top end of the cutting being in cooler soil does not start. When, therefore, the bundles of cuttings are taken up in the spring and set out, the roots, being already started, soon develop a root system large enough to provide food and water for the top when it begins to grow. Cuttings may also be stored in damp sand in a cellar where the temperature can be kept fairly low, but not below freezing.

Setting the Cuttings.—The cuttings should be set out in the spring as soon as the soil has become warm enough to be well fitted. Trenches of the proper depth are opened, usually with a plow, and the cuttings are set in them usually in a slanting position and about three to six inches apart. The rows are placed far enough apart to allow for the cultivator, and the soil is firmed down carefully about the cuttings which are buried so as to have only the top bud (or two) exposed. A moderately fertile soil is desirable to produce a good growth, and the soil should be thoroughly prepared and should be kept well cultivated to insure keeping down the weeds and keeping up an abundant supply of moisture.

When to Transplant.—The vines grown from cuttings in this way may be dug and sold at the end of the first season as one-year plants, or they may be grown for another year in the

nursery and sold at two years. When grown for this second season they are sometimes transplanted to new ground and sometimes allowed to stand where they were originally set.

Opinions differ as to the relative value of one-year and two-year vines for setting. Apparently the majority of growers

FIG. 153.—A vigorous one-year grape vine.

FIG. 154.—Same vine as shown in figure 153 with roots pruned ready for setting.

prefer the one-year vines, since only those plants which are vigorous and growthy will be large enough at the end of the first season to be marketed (Figs. 153 and 154). Growers who prefer these one-year vines contend that the two-year vines are merely the culls which are so small at one year that they will not sell (Fig. 155), and the nurseryman is forced to grow them an additional year in order to get them to a reasonable size. On

the other hand, there is no reason, of course, why vigorous one-year vines might not be grown for another year in the nursery and this is sometimes done. For this type of two-year plant there is much to be said, and some growers will use no other type (Figs. 156 and 157).

Single-eye Cuttings.—With new varieties, where wood is very scarce, single-eye cuttings are used. These cuttings, as the name implies, have only one bud with about an inch of wood on either side of it. The entire cutting is buried an inch or so below the surface when it is set. These cuttings are often handled in flats placed in hotbeds or cold frames, or more frequently in a bench of a greenhouse. They do not, of course, produce as strong plants as the longer cuttings, and they require special care to bring them to marketable size, which means extra cost of production. But for rare, new varieties, vines of which can be sold at high prices, the method will no doubt pay.

Fig. 155.—A weak one-year grape vine. Such a vine must be grown another year before it is large enough to be marketable.

Layering is also used with those species or varieties of grapes which root with difficulty. For this purpose a one-year cane is selected, starting from near the base of the old vine, and this cane is buried a couple of inches below the surface of the ground. This may be done either in the autumn or spring, but preferably the latter. The trench should be opened to the proper depth and the canes bent down and fastened in the bottom, but it is not covered until the buds have started into growth. When these new shoots have grown for six or eight inches, so as to be well above the trench, the earth is filled in and firmed down about them, and they soon strike roots. In case the variety is one which roots with particular difficulty, an incision is sometimes made opposite each bud on the original cane at the time it is laid down. Like any other wound, this incision tends to

draw the elaborated food to this point and assists materially in the rooting process.

Grafting is also used to a limited extent with grapes. The

FIG. 156.—A strong two-year grape vine.

FIG. 157.—Same vine as figure 156 with roots pruned for setting.

most common reason for using this method is to secure vines of varieties which would be seriously injured by the phylloxera on roots of some variety which is resistant to that pest. Another reason is to work over poor varieties to better ones just as is done with apple trees.

This grafting may be done on established vines in the vineyard or nursery, or it may be done on cuttings or young vines handled in a cutting bench in the greenhouse. The cleft graft is the method most commonly used, but the various types of the whip graft are also popular. The saddle-graft is sometimes used on established roots. The work is more difficult than grafting such fruits as apples, principally because of the character of the grape wood, and some special points have to be observed in the work to make it successful, but there is no reason why one who is successful with other types of fruits might not succeed in grafting the grape.

Starting New Varieties.—When new varieties are desired, the grape is propagated by seeds, and the resulting plants usually bear little resemblance to the parent variety. There are, for example, many white grapes among the seedlings of the Concord. This method is used, of course, only by the experimentalist who is willing to spend time and money in the hope of getting some new variety of value, since for every seedling which he gets that has merit there are thousands that are absolutely worthless.

Preparing the Site.—If possible the site selected for the vineyard should be set to some cultivated crop the year previous in order that the soil may be brought into a fine condition for the vines.

The land for the vineyard should be plowed early in the spring and should be thoroughly fitted. Ordinarily it is not best to plow the land in the autumn because the site is generally sloping, and on such land there will be too much wash during the winter and early spring. But if for any reason a site has been selected that is not sufficiently sloping to make washing dangerous, then it would be best to plow it in the autumn.

Plowing in Narrow "Lands."—Some growers make a practice of plowing the field where the vineyard is to be set in narrow "lands," each one just the width of the distance between rows of the future vineyard, say, eight or ten or twelve feet apart. This, of course, brings dead furrows through the field at the distance apart that the rows are to stand and in the

bottom of these dead furrows a subsoil plow is run once or twice to break up the subsoil thoroughly. The vines are then set along this furrow, digging out with a shovel whatever additional soil may be necessary to make a hole deep enough to accommodate comfortably the roots of the vines. This method has much to commend it, since it insures a fine, deep reservoir for soil moisture directly underneath the vines.

Careful Preparation.—Whether this particular method of plowing is adopted or not, the soil should next be thoroughly pulverized, using a disk harrow first, to be followed by any other types of harrows that may be available. For while it is not necessary to give quite such thorough preparation of the soil as is given for strawberries, yet the vineyard is a long-term crop and it will never again during the life of that vineyard be possible to fit the soil as thoroughly. If the land is not properly prepared it may easily take two years for the vines to make up for this lack of a few hours' or days' work on the field.

Spring Planting.—Like any other fruit plantation, the vineyard ought to be set early, just as early in the spring as the land can be plowed and fitted after the soil gets dry enough to work properly. This gives time for the newly-set plants to settle into place and become established before the warmth of advancing spring forces them into active growth.

Distances for Planting.—As already suggested, the distances at which the vines are set vary considerably. For the smaller-growing varieties, as Delaware, or on soils where the growth is not expected to be large, or with very severe methods of pruning, nine feet apart for the rows, or even eight and one-half feet with vines seven or eight feet apart in the row, are common distances. While for larger-growing varieties or more fertile soils or with the less severe methods of pruning, rows ten or eleven feet apart and vines nine or sometimes ten feet apart in the row is the usual arrangement. There has been a fairly well-marked tendency of late years toward closer planting of grapes, but it seems doubtful whether it is well to crowd them closer than the smaller distances suggested.

Establishing the Rows.—The distances having been decided,

the land is staked off in both directions. Since the trellis will soon prevent cross-cultivation, less care is usually exercised than with orchards to get the rows accurate in that direction. Some method of range stakes which can be set up and used to sight the vines into place is usually sufficient. In the direction of the rows much more care is exercised, but even here the range-stake method is usually satisfactory. Often the rows are furrowed out, either by plowing the field in narrow lands as already suggested and planting in the dead furrows, or else by special furrows made after the soil has been fitted.

The direction in which the rows shall run is often decided by the shape of the field to be set, but several considerations are worth keeping in mind in this connection.

1. If the slope is steep the rows should run across the slope of the hillside in order to reduce the washing of the soil as much as possible.

2. Other things being equal it is best to have the rows run north and south, as this gives a more uniform illumination by the sun, giving the most shade to the fruit when the sun's heat is most fierce, and providing equal shade for both sides of the row.

3. Where winds are strong it is best to have the rows run in the same direction as the most severe winds, as there will thus be the least damage from the winds.

The vines should be carefully heeled in on arrival, especial care being taken to tramp the soil firmly down about them to prevent their drying out. But even then it is well not to allow them to stand too long, but to get them set out permanently as soon as possible.

The vines are prepared for setting by trimming back the roots rather severely if the nurseryman has not already done this (Figs. 154 and 157). From six- to eight- or possibly ten-inch roots are considered ample, the shorter lengths being used where the root system is abundant. The top is cut to two, or at the most to three, buds.

Digging Holes and Planting.—The holes are best dug with a round-pointed shovel and should be wide enough and deep enough to accommodate the roots comfortably. Twelve or fifteen

inches wide by the same in depth will usually be found ample and will allow room for a good quantity of surface soil to be shoveled back into the bottom of the hole under the vine to insure a good start.

The vines should be set fairly deep, leaving only the buds above the surface when the soil is finally all filled in. There is always a tendency for grape vines to work to the surface, either by being heaved up by frosts, or by the washing away of the soil, so that it is well to set them as deeply as possible and still have the buds above the surface of the ground. The soil should be tramped firmly about the roots except that the surface layer is left light and friable as a mulch.

No Trellis at First.—During the first season it is usually customary to allow the vines to run at will over the surface of the ground, and this practice is sometimes continued during the second season, but by the third season, at the latest, the trellis ought to be established.

QUESTIONS

1. Describe the propagation of grapes by cuttings.
2. What are the arguments in favor of one-year and two-year grape vines for setting?
3. Describe the propagation of grapes by single-eye cuttings.
4. By layers.
5. How and why are grapes grafted?
6. How are new varieties of grapes secured?
7. Describe the preparation of the soil for a vineyard.
8. What distances are best in setting a vineyard?
9. How would you lay off a vineyard in your own locality on a hillside sloping to the southeast?
10. How should the vines be handled on arrival from the nursery?
11. How would you prune a grape vine at setting?
12. Describe the setting of a grape vine.

CHAPTER XXXIII

CULTIVATING AND FERTILIZING THE VINEYARD

If good results are to be secured from the vineyard it must be given thorough cultivation. All authorities, practical as well as theoretical, agree on this point.

Plowing.—It is ordinarily best to begin operations in the spring by plowing the land rather shallow, not over four or five inches. This can usually be done with the gang plow shown in figure 2. Some growers make a practice of going through the vineyard ahead of this gang plow and throwing one furrow towards the vines with a one-horse plow when the plowing is to be done towards the rows. Or if the plowing is to turn the soil away from the rows, then the one-horse plow or the grape hoe is used after the gang plow to finish up along the rows. In either case the idea is that one can get closer to the rows with the one-horse plow or the grape hoe than with the gang. This is doubtless true and the practice is probably a good one, especially when the plowing is away from the vines and when it is considered particularly important to stir all the soil. On the other hand, very satisfactory work can be done with the gang plow alone, and certainly when the plowing is towards the vines it leaves little to be desired.

Disking.—When the soil is rather light and mellow, and particularly if there is comparatively little material to be turned under (cover-crops, weeds, or barnyard manure), the disk harrow is often substituted for the plow. Three or four times over the land will usually leave the soil in good condition. But under most conditions it is best to plow rather than to disk, because with the gang plow the vineyard can be gone over very rapidly, and one usually gets a somewhat better job than with the disk.

Tillage Against Root-worm.—It is a common practice, and probably a good one, where the root-worm is troublesome, to plow a single furrow towards the vines from either side, just before cultivation is stopped for the season, the idea being to

induce the insects, which pupate in the soil, to form their cells higher above the roots than they normally would. Then about June 15th, or earlier in the southern states, this ridge is thoroughly worked down, thus exposing the pupæ. This practice itself will kill many of them, and the balance are open to the attacks of enemies.

After plowing, the soil should be thoroughly fitted with the disk harrow, and from that time on the land should be thoroughly and frequently cultivated, using the grape hoe (Fig.

Fig. 158.—The grape hoe at work in the vineyard. Such an implement will greatly reduce the cost of handling the vineyard, since there will be little need of hoeing.

158) or the cultivator. In some vineyards, where the rows are fairly widely spaced, a two-horse cultivator is used.

Shallow Tillage.—In all cases, whatever the implement used in the work, the cultivation should be shallow, and it should become more shallow as the season progresses. Of course, when plowing or disking is done to start the work of the season, this destroys the roots to a certain depth, and following this the cultivation may be fairly deep. But as soon as growth starts and the new roots begin to form in this soil, as they will immediately, the cultivation should be made more shallow, until towards the end of the season it is very shallow indeed.

Preventing a Crust.—Just how often to cultivate will, of

course, depend on circumstances, on weather conditions, on weeds, and on the type of soil. It should be the practice to get over the vineyard after every rain (unless they are very frequent indeed), and the drier the season the more important this point is. The best practice is to watch conditions and get into the vineyard with the cultivator before any crust can be formed in the drying out of the soil. The heavier the preceding rain or rains have been the more heavy and solid the resulting crust will be, and therefore the more important it will be to have it broken up.

Frequency of Cultivation.—Cultivation ought to be more frequent in dry weather than at any other time, for it should be borne in mind that there is always a tendency to form a crust even in long periods without rains, the soil settling down gradually and transpiration being increased thereby.

Probably a good rule as to frequency of cultivation is to get over the vineyard once in every ten days as a maximum period, and oftener if weeds are troublesome or if rains have occurred.

Level Tillage.—By all means let the cultivation be level. This means that only comparatively small-toothed implements should be used for the work. The only exception to this rule would be where such a weed as witch (quack) grass has become troublesome, in which case a larger toothed cultivator, or even a disk harrow, may be used, but it should be followed by some implement with smaller teeth.

Cross-cultivation.—During the first season after the vines are set out the vineyard may be cross-cultivated, which, of course, reduces very decidedly the cost of keeping it clean. Usually it is possible to get through with the cultivator crosswise for a time during the early part of the second season before the vines have made much growth. But thereafter it will be possible to cultivate only in the direction of the rows, and the work in the rows will have to be done with hand hoes and with the grape hoe. A man who is skillful with the latter implement can reduce the amount of hand work necessary to a very small amount.

Companion Crops.—It is fairly common practice in some sections to grow some companion crop, such as cabbages or po-

tatoes, in the vineyard during the first season, and sometimes during the second season. It is a question just how wise a practice this is, and the answer to this question, like that to a good many others, depends on circumstances. If the crop grown is one that requires good culture, if the soil is in first-class condition, and if the grower is a good farmer who keeps his work well in hand (Fig. 159), the vineyard will probably not be hurt

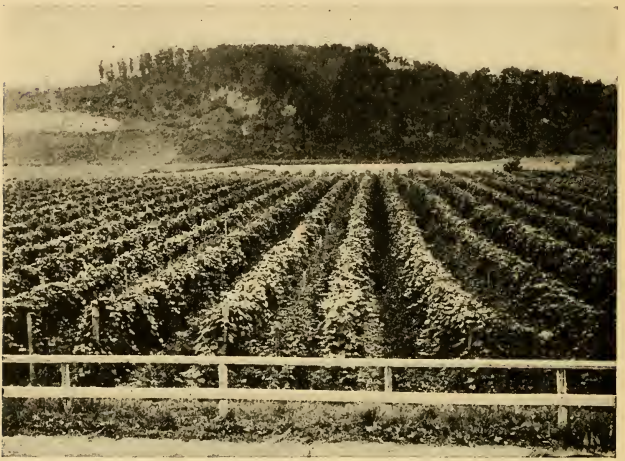

FIG. 159.—A young vineyard inter-planted with raspberries. This is intensive cropping and demands careful management to see that neither crop suffers.

any by the companion crop, and the owner may gain some revenue from it. But if any or all of these conditions do not obtain, then it is very probable that the vineyard may be damaged more than the owner's bank acount is benefited. In vineyards of the lower Hudson River Valley growers often use such crops as currants, gooseberries, raspberries, and strawberries as companion crops. These perennial crops remove too much moisture and plant food at the very season that the grapes need them. They also lessen the amount of tillage possible.

Uses of a Cover Crop.—At the end of the period of cultivation it is the common practice, and generally a good one, to seed down the vineyard to a cover crop. The three principal functions which this cover crop is expected to perform in the vineyard are (1) to add humus to the soil; (2) to prevent washing of the soil, and (3) to add nitrogen. These are all important functions, of decided value to the vineyard, and usually far more

FIG. 160.—Buckwheat as a cover crop in the vineyard. Buckwheat is one of the best crops for this purpose.

than offset any disadvantages that may come from the use of the cover crop, such as interfering with the harvesting of the crop. Humus is important in almost any soil, but especially so in the types that are usually selected for grapes, and with the very thorough cultivation which is given to vineyards, which tends to burn out the organic material in the soil very rapidly. The washing of the soil in vineyards is sure to be considerable and is often very serious, owing to their being located on hillsides; while the addition of nitrogen through cover crops is very desirable, since one must have a vigorous growth of vines if the

crop of fruit is to be good, and no form of nitrogen is better and none so cheap as that secured by the cover crop.

Crops to Grow.—Several different crops are popular for this purpose. Among the best are buckwheat (Fig. 160), barley (Fig. 161), rape and cowhorn turnips, among the non-nitrogenous crops; and crimson clover and vetch are good nitrogenous

FIG. 161.—Barley as a cover crop in the vineyard. This is an excellent crop for the purpose, giving a large amount of growth to plow under for humus.

crops. The following are the amounts of each per acre which are usually sown:

Buckwheat	1 bushel.
Barley	1½ bushel.
Rape	2 to 3 pounds.
Cowhorn turnips	2 pounds.
Crimson clover	15 pounds.
Vetch	1 bushel.

It is often, in fact, usually, best to use a mixture of two of these crops if one is to secure the best results. A half bushel of buckwheat, with 6 or 8 pounds of crimson clover, or 15 or 20

pounds of vetch, will make an admirable mixture. Or barley may be substituted for the buckwheat. This general type of mixture is best because it contains one rank-growing crop to produce the humus, and one low-growing, nitrogen-gathering crop to prevent the soil from washing and to add nitrogen to the soil. Cowpeas are good for summer growth in most states south of Massachusetts. Burr clover is good for winter growth in the Gulf States.

Fertilizing.—The practice, theory, and recommendations in reference to the fertilizing of vineyards are very variable and even chaotic, but it is doubtful if they are much, if any, more so, than they are with many other fruits.

Certainly it is safe to take this position in reference to the subject that until all other factors in regard to the handling of the soil of the vineyard have been brought to a high state of effectiveness one ought not to spend money on fertilizers. If the soil has been poorly prepared in the spring; or if it is indifferently cultivated through the season that weeds are abundant and thrifty; or if the land is poorly drained, then money spent on fertilizers is largely thrown away. At least, it is poor policy to put money into fertilizers until the soil has been put into cultivation and drainage, so that the natural fertility of the soil may be fully utilized. But all this might be said with equal truth of an apple orchard or a strawberry plantation.

Having attended to the drainage and cultivation and preparation of the soil, and having sprayed and pruned the vineyard so that the foliage is healthy, it is then in order to consider the use of fertilizers, and if after all this has been done the vines are not making a good growth and producing good crops of fruit, then one of two things ought to be done: either the vineyard ought to be pulled out, or else fertilizers ought to be used.

What Fertilizers to Use.—Having decided that fertilizers are necessary, the next question is as to just what forms and amounts shall be used. It seems probable, from a study of both experiments and vineyard practice, that nitrogen is more likely to be needed than either potash or phosphoric acid. If the vines are not making a good growth something must be

done to stimulate them, and the cultivation being good, the use of nitrogen is the next most reasonable step. Barnyard manure is probably the most popular form in which to apply nitrogen, and a light annual application, at least on the lighter soils, will usually bring good results. Of course, it also carries some potash and phosphoric acid and a great deal of humus, all of which help. Where barnyard manure is not available, nitrate of soda and tankage are good forms to use.

On the lighter soils some potash in the form of either the muriate or the high-grade sulfate is likely to be helpful, but it is generally not needed on the heavier soils; or if needed, a smaller quantity will be sufficient, and it is better applied in the form of wood ashes. On most types of soils it is a common custom, and probably a safe one, to apply some phosphoric acid, either in the form of bone meal, acid phosphate, or basic slag.

Soils Differ.—Another point which ought not to be overlooked, and which has been brought out very forcibly by some work by the New York Station at Geneva, is that different parts of the same vineyard will probably vary greatly in their fertilizer needs. One part is poor and gravelly and needs all elements of the fertilizer, another part is a stony soil and needs only humus or perhaps humus and phosphoric acid, while a third part is a sandy loam and needs perhaps only potash and nitrogen.

Doubtless the surest and best way to decide this question of fertilizing vineyards is for the grower to experiment. Try one or two forms of nitrogen, combined with some acid phosphate or bone, and some potash, if it can be had, and note results.

In the meantime the writer would continue to use fertilizers in the vineyard, and the following is a formula which has been used and with good results:

Basic slag	300 pounds.
High grade sulfate of potash	200 to 300 pounds.
Tankage	200 pounds.
Nitrate of soda	100 to 200 pounds.

Three hundred pounds of acid phosphate or bone meal may be substituted for the basic slag.

These amounts are per acre quantities, and the rate of application may well be varied according to soil conditions, applying more on those sections of the vineyard where the soil is poor and the growth of vines and fruit not satisfactory, and less on those parts where conditions are better. In fact, some growers make the application of nitrogen practically a per-vine matter, applying it as a separate operation from the other fertilizers and giving each vine what it seems to need. This necessitates good judgment on the part of the man applying it, but if a man with the requisite judgment is available, it is a good method.

When to Apply Fertilizers.—The manure, if used, and if it is made on the farm, is generally applied during the winter and is always applied before the vineyard is plowed. The other fertilizers are applied broadcast shortly after plowing in the spring. The best and most economical way, if the soil is uniform, is to apply them with a fertilizer distributor, but if the application is to be varied in different parts of the vineyard, of course, this cannot be done and one must necessarily resort to application by hand.

QUESTIONS

1. Describe the plowing of a vineyard.
2. How would you fit the land after plowing?
3. Describe the ideal tillage for a vineyard.
4. Would you use companion crops in a vineyard of your own? Why? What crops?
5. Would you sow a cover crop in a vineyard? What crop in your section? Why?
6. Ought vineyards to be fertilized?
7. What is a good fertilizer formula for a vineyard?
8. When and how would you apply fertilizers?

CHAPTER XXXIV

PRUNING AND TRAINING THE GRAPE

In no other fruit has the pruning been reduced to so exact a science as with the grape. Systems of training have been developed with their accompanying methods of pruning, so that there is relatively little chance for the exercise of judgment in the matter. This is entirely relative, however, and there is still ample opportunity for difference between a grape vine pruned by a skilled operator and one pruned by a novice. But as compared with an apple tree or a plum tree the pruning of a grape vine is a very simple matter indeed.

It might be said also that the pleasure and interest in the work of pruning have likewise decreased. To the one who likes to have his decisions made for him by someone else, it may seem like a more enjoyable occupation, yet to the one who takes a personal interest in his plants the operation is too harsh and drastic to be really relished. He will finish pruning many a vine with the conviction that he has treated it brutally and frequently that he has ruined it.

Two Important Facts.—There are two facts which must constantly be kept in mind in pruning any grape vine intelligently. These are: (1) That *the fruit of the grape is borne near the base of the current season's growth;* and (2) that *these shoots, in order to bear fruit, must come from buds on last season's wood.* If these two points are kept in mind and the system of training to be used is understood, one cannot go far wrong in pruning.

Placing of Flower Clusters.—It ought further to be said that not every shoot of the current season will bear fruit, but that when fruit is produced it comes on this wood. The bud will start into growth (Fig. 162) in the spring and grow for a node or two without producing anything but leaves; then will come a node with a blossom cluster on one side and a leaf on the opposite side of the shoot from it. The next node or joint will also

bear a leaf and a blossom cluster, but their positions have been reversed from those at the previous joint; and so on until from one to four clusters have been produced, after which the shoot may continue to grow for a long distance, perhaps as much as ten or fifteen feet, without producing any more blossoms. The number of such blossom clusters produced (and, to a certain extent, their arrangement) depends on the variety, the age of vine, the botanical species, and the individual winter bud (its size, position on the cane, etc.).

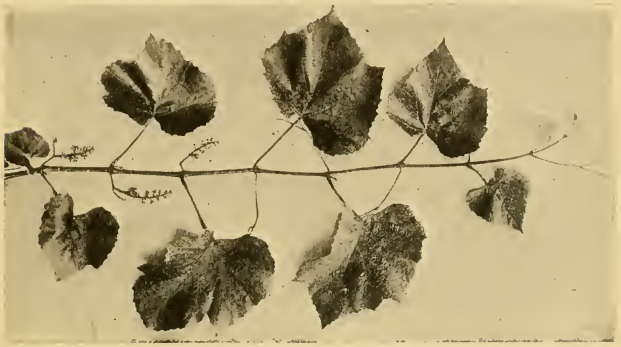

FIG. 162.— Young shoot of the grape showing the arrangement of the clusters at the base of the shoot. Such a shoot may grow on for many feet, but the fruit is borne only at the first few nodes.

Leaving a Few Buds.—While the second fact, that these bearing shoots arise from buds on the canes which grew last season, may have a few exceptions, they are very few indeed. If, in pruning, one removes all of last year's wood from a vine, he need expect little or no fruit. There will be some unusually vigorous shoots sent out to take the place of the wood removed, but they will bear no blossoms. Their very vigor is apparently against this, and the vine bends all its energies to renewing the supply of wood.

Since it is true that one must save last year's wood in order to secure any fruit, it is important that we learn to distinguish

the wood which grew last season from the older wood. Of course, the relative position is a strong indication, the one-year wood growing out from the two-year, but in addition, it will be found that last year's wood has a smooth bark, while on the older wood the outer bark has become loosened and shredded and hangs more or less in strips. Figures 163 and 164 illustrate this difference.

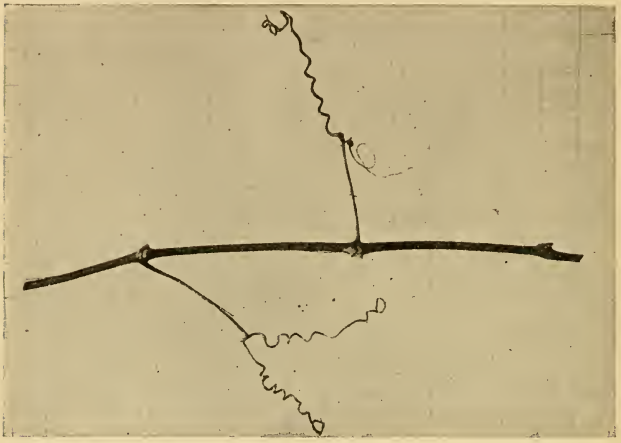

FIG. 163.—Part of a young grape cane, showing the type of wood which must be retained in pruning in order to produce fruit.

Figure 162 shows the young, growing, fruit-bearing shoot which started from such a bud as is seen on the sides of the cane shown in figure 163.

Parts Defined.—It may be well to distinguish here between a few terms which will be used frequently in the discussions which follow on the various methods of training and pruning grapes. The four important ones are the following:

1. A *shoot* refers to a young growing branch on the vine and may properly be applied to this branch during its period of growth. It is on the shoots that the fruit will be found (Fig. 162).

2. A *cane* refers to a branch which grew the previous season.

3. An *arm* is an older branch which is run on the trellis in a horizontal position.

4. A *trunk* is the main stem of the vine which is usually in a vertical position.

Of course, these different parts are likely to merge gradually into each other, the shoot gradually becoming a cane, the cane sometimes being used as an arm or trunk, and so on; but the distinctions are useful and will generally hold.

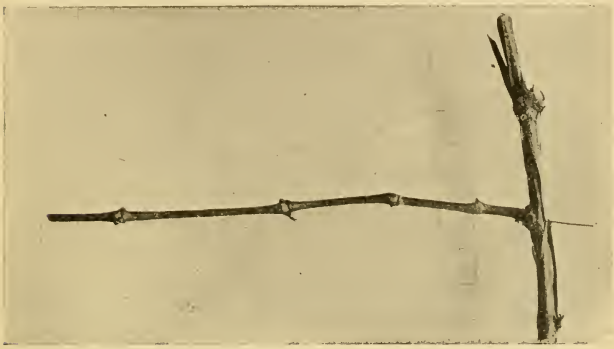

FIG. 164.—One and two-year wood of the grape. Note that the bark is smooth on the one-year section and shredded on the two-year part.

The First Years of Pruning.—When the young vine is set out it is pruned back to from one to three buds, depending on the strength of the vine and the ideas of the pruner. Tools are shown in figures 165 and 166. And after a year's growth it is usually pruned back just as severely, *viz.*, to not over three buds. As a result of this very severe pruning the young vine will usually make a very strong growth and may be ready the following year to be put on the trellis. During these first two years, however, it is generally allowed to straggle over the ground, or at most (and this very seldom) is tied up to a stake.

At the beginning of the third season, if a good growth has

been made, the young vine is brought on the trellis and its training for the desired system is begun. Just what position it

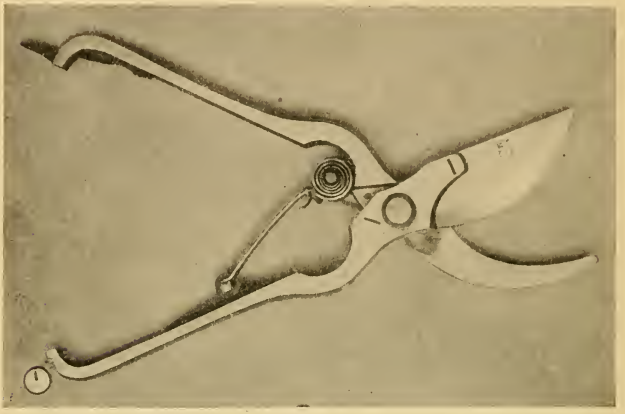

FIG. 165.—A good type of shears for pruning grapes.

FIG. 166.—A small saw will be needed when heavy trunks are to be taken out as in renewing vine shown in figures 174 and 175.

will be made to assume at this time will depend on what the system of training is to be, and can best be discussed under each of the different systems.

Spur and Renewal Systems of Pruning.—Before discussing

the individual systems of training which are to be presented, one other general question ought to be understood thoroughly, and that is the difference between spur and renewal systems of pruning. All the various methods of pruning can be classified under one or the other of these two systems. In the spur systems the required amount of last year's wood is secured by leaving a large number of short spurs of this wood, each spur containing two or three buds (Fig. 172), so that if a particular

FIG. 167.—Grape vine in fruit trained on the high renewal system.

system contemplates the retention of, say, thirty buds, there will be about ten to fifteen spurs saved. With the renewal systems, on the other hand, the required number of buds is secured by retaining fewer but longer canes, usually from two to four. In the four-cane Kniffin system, for example (Figs. 173 to 176), if thirty buds were wanted, they would be on four canes, two containing about ten each, and two five each.

The following systems of training are selected because they are types, and some of them, at least, are perhaps more generally used than any others. It ought to be understood, however, that

every section (and almost every grower) develops slight modifications, and sometimes fairly radical ones, of the general system in use.

I. High Renewal System.—In this system, which is well illustrated in figures 167 to 170, the vine is cut back very severely, only two canes three to four feet long being retained each year. These are tied on the lower wire, and the new shoots,

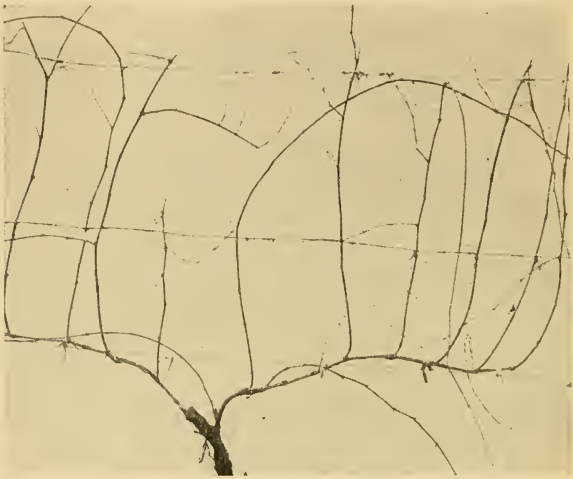

FIG. 168.—A grape vine trained on the high renewal system, before pruning.

as they grow, are tied up successively to the second and third wires, so that at the end of the season the vine has the arrangement shown in figures 167 and 168.

The trellis for this system consists of three wires, the lower one 20 to 30 inches from the ground and the other two about 18 inches apart. The two canes which are reserved are tied to the lower wire, as shown in figure 170. Then as the young shoots grow they are tied to the second and third wires, as already suggested. This requires careful watching in order to do it at

just the right time, since the shoots cannot be tied until they have grown somewhat longer than the distance between the two wires. On the other hand, if allowed to grow very much beyond this length the tendrils begin to catch on the wires and pulling them loose adds decidedly to the labor of tying, besides somewhat injuring the shoots.

When the young vine is first put on the trellis in this system

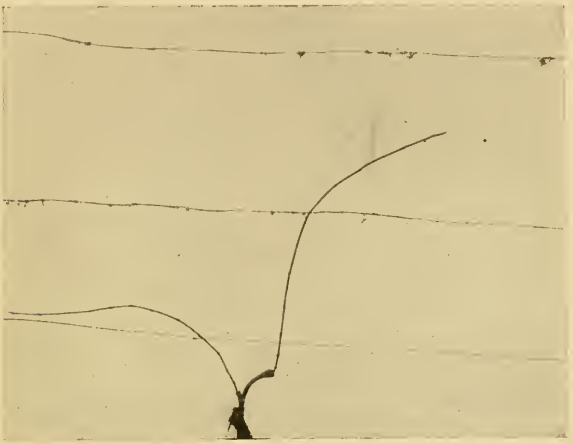

FIG. 169.—The same vine as figure 168, after pruning.

it is pruned back to a single cane, the longest and best one being selected. This is brought up in a vertical position and tied to the lower wire, and is then bent sharply to the right or left, and tied along this wire, two or three additional ties being used.

The principal advantages claimed for this method of training are as follows:

1. The sunshine and heat are well regulated, so that the fruit gets about the right amount. The question of the desirability of increasing the heat will, of course, vary considerably with the section of the country. Where heat is needed to insure that the

crop will ripen, some low system like this is especially desirable. In sections of the country where the heat is intense, some of the higher systems, as the Munson, are much better, since they get away from the intensity of the reflected heat.

2. The fruit is convenient to pick, being all grown in the neighborhood of the lower wire.

FIG. 170.—The same vine as figures 168 and 169 after tying.

3. There is no chance of the clusters of fruit becoming tangled among the growing shoots and little danger of its growing around the wire and having to be torn to pieces at picking time.

4. The pruning for this system is very simple, two cuts being about all that require any judgment, the rest being merely routine work.

5. It retains little old wood and not very much young, so that most of the vigor of the vine goes into the fruit, producing fine clusters.

There are three disadvantages, however, which may be worth mentioning:

1. It requires three tyings, and the last two of these require that the vines be watched carefully, so that work may be done at just the right time.

2. There are frequently no satisfactory canes at the two points where they are desired, and the operator must adjust his method very decidedly to meet the conditions, being even forced

FIG. 171.—A grape vine trained on the horizontal-arm spur system, before pruning.

at times to change one or both sides of the vine from a renewal to a spur method.

3. The fruit, while it is convenient to pick because the clusters are all close together, is so low that it requires the operator to work in a stooping posture, which becomes tiresome.

Directions for Pruning.—The following directions will be found useful in deciding how vines shall be pruned on the high renewal system:

1. Prune back each side of the vine to the first strong cane.

2. If weak canes are removed near the trunk, save one bud at the base of each to grow a cane for use the following year.

3. Cut back canes saved to three feet.

4. Where the vine has two trunks, get rid of one of them if possible.

5. Cut off canes which are retained to one-half inch beyond the last bud.

II. The Horizontal Arm Spur System.—This is well shown in figures 171 and 172. Except for its being a spur system of pruning instead of a renewal, the discussion of it would be

FIG. 172.—The same vine shown in figure 171, after pruning.

practically the same as that just given under high renewal. The great disadvantage of the spur method of pruning is that so much old wood is always retained and that eventually this wood becomes very old and hard. The spurs also necessarily tend to elongate a joint or two every year and soon become so long as to be decidedly objectionable, as will be seen in figure 172. For these reasons this system is relatively little used at present as a regular custom, and spur pruning is only practiced when the operator is forced into it in some other method of training through lack of good renewal canes.

III. Four-cane Kniffin System.—This is one of the most

common and popular methods of training in the northeastern grape section. The method is well shown in figures 173 to 176. The trellis consists of two wires, the lower one usually about three and one-half feet from the ground, and the upper five and one-half feet or six feet. In starting a young vine on this

FIG. 173.—Grape vine in fruit trained on the four-cane Kniffin system.

method, a strong cane is secured and is carried vertically to the top wire and then bent sharply to the right or left and tied to this wire. As soon as possible the vine is developed into a double T, as shown in figure 176. Thereafter each year's pruning consists in getting it back as nearly as may be to this shape, retaining on the upper wire two canes about three feet in length, and on the lower wire two canes of about half that length.

Points to Observe in Pruning.—The following directions will bring out the principal points to be observed in pruning on this system:

1. Save the first strong cane on each arm. Be sure that this is one-year wood.

2. Cut the two upper canes about three feet long and the two lower ones about one and one-half feet long.

FIG. 174.—A grape vine trained on the four-cane Kniffin system, but in need of renewal. The previous season two trunks were allowed to remain to provide for this renewal.

3. If weak canes are removed nearer the main trunk than those saved, retain one bud at the base of each one to grow a new cane for use the following year.

4. Be sure that the tip of each cane saved is cut back to live wood.

5. In case there is no strong cane on any particular arm within a reasonable distance of the trunk (say, one and one-half feet), use the spur method on that arm.

6. Cut off canes retained one-half inch beyond the last bud.

7. Renew arm or trunk where desirable and possible.

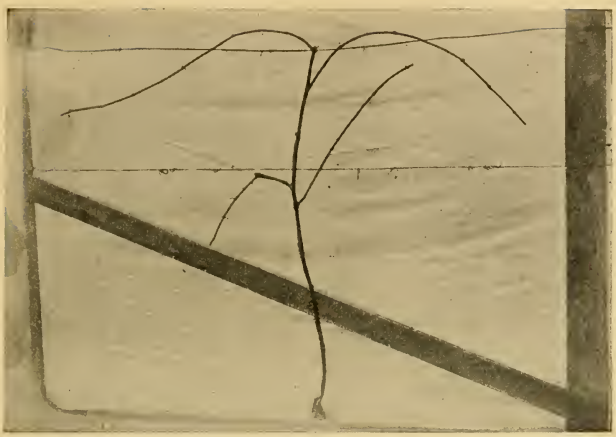

FIG. 175.—The same vine as shown in figure 174, with the old trunk removed and the vine pruned.

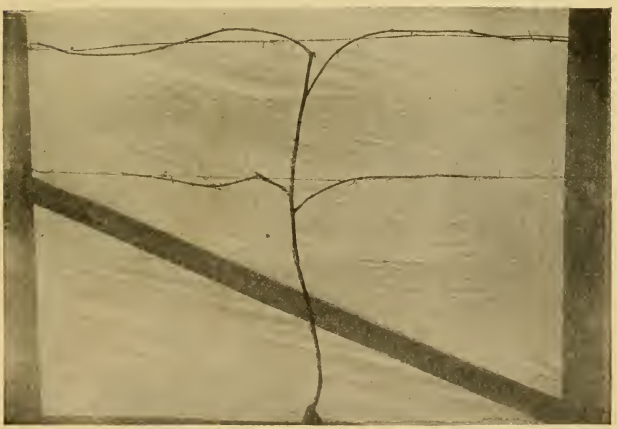

FIG. 176.—Same vine as shown in figures 174 and 175, after pruning and tying.

The principal advantages claimed for this system are the following:

1. There is relatively little labor to it, since the vines take care of themselves once they have been pruned and tied up each spring. Some people have been unkind enough to call it the lazy man's system.

2. It is a renewal system.

FIG. 177.—Grape vine in fruit trained on the one-wire or two-cane Kniffin system.

3. Vines grown on this system will produce a large amount of good fruit.

4. The fruit usually receives about the right amount of sun and heat.

5. There is no summer tying.

6. The fruit is at a convenient height to pick, neither so low as to require the operator to bend over, nor so high as to tire the arms in reaching up to it.

The chief disadvantages of the four-cane Kniffin system are:

1. The fruit is likely to get tangled in the wires and shoots. This results from the fact that the growing shoots, instead of

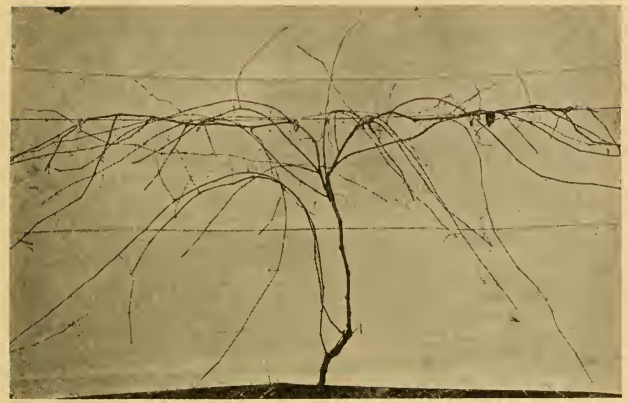

FIG. 178.—A grape vine trained on the one-wire, or two-cane Kniffin system, before pruning.

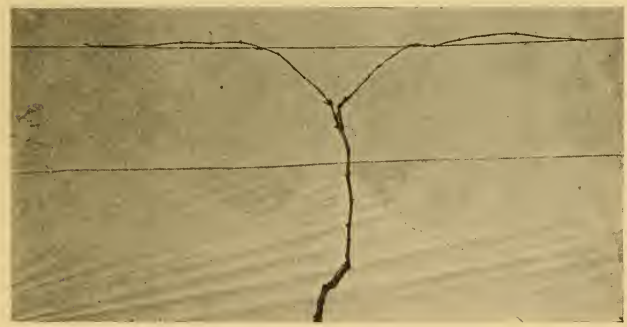

FIG. 179.—The same vine as shown in figure 178, after pruning and tying.

drooping down from the wires, as they are often represented as doing in diagrams, really grow along the wires crossing each other and the wires frequently. This makes a network in which the growing clusters are very likely to get entangled, so that they have to be badly broken up in picking them.

2. It retains too much wood for the best fruit with some varieties. Of course, this difficulty can be overcome by cutting back the four canes saved very severely.

3. The overlapping vines may give too much shade.

But on the whole, it is a very satisfactory method of training and is used (either in the regular method here described or in some modification) by a great many men who are not lazy.

FIG. 180.—Grape vine in fruit, trained on the umbrella system.

IV. The two-cane or one-wire Kniffin system is essentially the same as the four-cane Kniffin except that, as the name implies, it carries only half as much wood. The single wire is placed at three to four feet from the ground and the two canes are each about three feet long. It is a better system than the four-cane for those varieties which do better with less wood, or for the grower who wishes to grow a somewhat better quality, though a less quantity, of fruit. It is illustrated in figures 177 to 179.

V. The umbrella system, which is well illustrated in figures 180 to 183, is a modification of the Kniffin. It is a renewal system, with two canes saved each year, but instead of these two

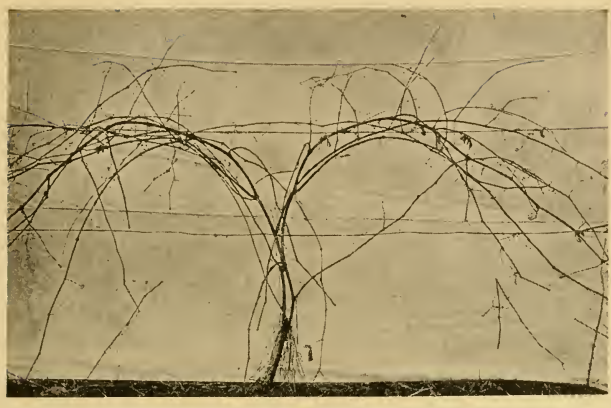

FIG. 181.—A grape vine grown and trained on the umbrella system, before pruning.

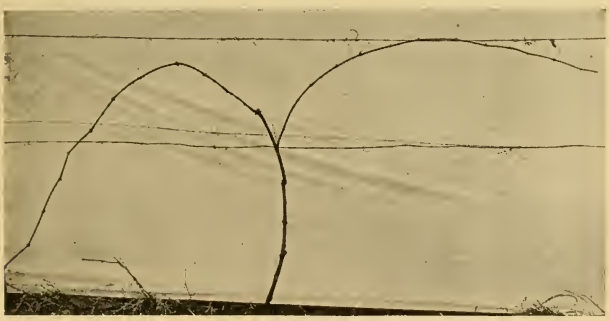

FIG. 182.—The same vine as figure 181, after pruning.

canes being tied out horizontally on the wires, they are started on the upper wire and bent down to the lower. The great advantage of this manner of tying the cane is that the buds along it start more evenly. There is less of the tendency (always seen more or less in plants) to push most vigorously from the ter-

minal and nearby buds, while those farther back remain dormant or push slowly.

The trellis for this system consists of two wires, the lower one two and one-half feet from the ground, and the upper one one and one-half feet above this.

When young vines are first put on the trellis with this system the best cane available is taken and pruned as long as possible. It is then carried direct to the upper wire and tied there. From this point it is curved outward and downward and tied again to the lower wire.

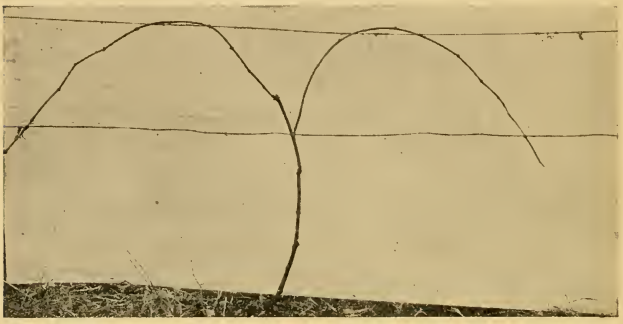

FIG. 183.—The same vine as figures 181 and 182, after tying.

Pruning for the Umbrella System.—The following directions for the pruning of this system will be found useful:

1. Prune back each side of vine to a strong cane which starts near the trunk, and at about the height of the upper wire.

2. Leave this cane long enough to extend, in a curved position, down to the lower wire about three feet from the trunk.

3. This cane should have from 10 to 15 buds.

4. Where no strong cane can be had spur-prune the old arm.

5. Where there are two trunks get rid of one of them if possible.

In tying, the trunk should be tied to the lower wire and to the upper wire if it reaches it. The two canes should each be

tied to the upper wire and then curved down and tied to the lower wire at a point about three feet away from the trunk, the tie being close to the end of the cane.

This system has about the same advantages as given under the Kniffin system, with the additional one, as suggested, that the buds start more evenly, and personally the writer is very partial to it.

VI. The Munson system has been selected as a type for the overhead systems because it is the best known and most widely used, and there are probably no others that are any better.

The trellis for this system consists of three wires. The posts are six feet high above the ground and at the top is nailed a cross-piece about two and one-half feet long. One wire is run along either end of this cross-bar, and the third is fastened to the posts about twelve inches below the other two, or in some cases is run through holes bored in the posts. The young vine is pruned to a single cane which is carried vertically to the lower wire and tied. It is then bent sharply to the right or left and tied along this wire. The method of pruning and training in mature vines is well shown in figures 184 to 186. The bearing canes, two to four in number, are tied along the middle wire, and the new shoots as they develop hang over the two outside wires. This particular vine shown in figures 185 and 186 is not ideal in shape because there are two trunks at the upper end, but one of these could be removed another year when more new wood had been developed from the upper part of the main trunk, or it might be removed now if the minimum amount of new wood is desired.

The advantages of the Munson system are enumerated here:

1. That the fruit hangs free from wires, canes or leaves, and hence does not get rubbed, but develops perfect clusters.

2. That in very hot countries the fruit escapes somewhat from the reflected heat.

3. That such plants as currants and gooseberries, which will stand a good deal of shade, may be grown underneath. This would probably not be done very frequently in commercial plantations, but is an excellent plan for home gardens.

FIG. 184.—Grape vine in fruit, trained on the Munson system.

4. It is a renewal system.

5. It is easy to cultivate, since there are no low canes and shoots to interfere.

The disadvantages are the following:

1. That in cool climates the fruit does not get enough heat.

2. That it exposes the vines to the winds. Both of these ob-

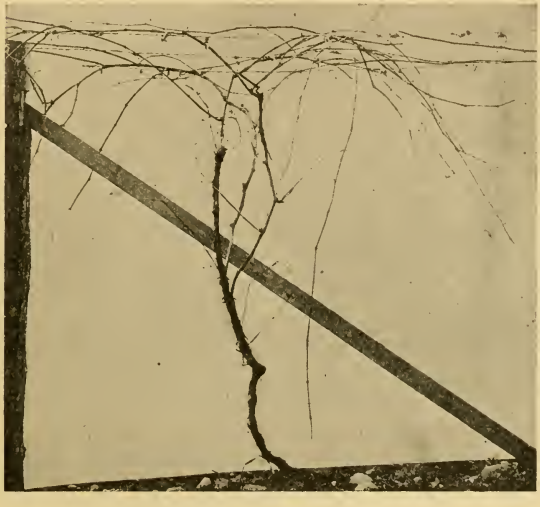

FIG. 185.—Grape vine trained on the Munson system.

jections (one and two) can be obviated somewhat by using lower posts, and this is frequently done, making them only four feet above the ground.

3. It is an awkward height to pick, bringing the arms at the shoulders in such a position that the operator tires easily.

4. The trellis is rather expensive.

It remains to say a word about trellises in general.

Erecting a Trellis.—The end posts are one of the most important factors in a good trellis. They should be heavy posts to

begin with, and should be set deeply, three feet being none too deep. If possible, select a post with a knot or enlargement near the lower end. If this cannot be had, nail one or two pieces of board about three or four inches long near the bottom end of the post. This will assist materially in preventing the post from being drawn up by the strain of the wires. In addition, these

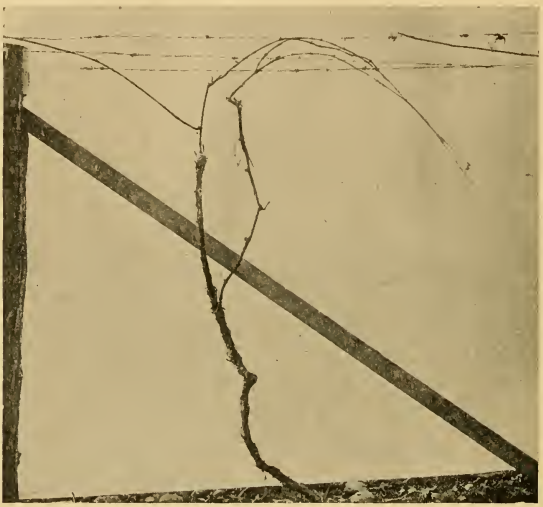

FIG. 186.—Same vine as shown in figure 185, after pruning. One of the trunks shown, preferably that at the right, might be removed if the minimum amount of new wood is desired.

end posts should be carefully braced. The brace should be long enough, so that it approaches a horizontal position, making a wide angle with the post, and should rest at the lower end against another post or a stake (Fig. 187). This position reduces the tendency to lift the end posts as will be done when the brace is more nearly upright, making a narrow angle with the end post, as shown in figure 188.

The wire used varies with the system of training and with

the district. The most common size is No. 12, which in some sections is used altogether. A better plan is to use a heavier wire, No. 9 or No. 10, on the part of the trellis where there is the most weight, and No. 12 where there is less strain. This would mean using No. 9 or No. 10 for the upper wire in the Kniffin systems and the Umbrella, and for the lower wire in the high renewal, horizontal arm spur, and Munson systems, since these are the points where the greatest weight of vines will come.

FIG. 187.—A good type of bracing for the vineyard. The braces are long and make a wide angle with the posts. Such a brace has little tendency to lift the posts.

There is some argument for using the heavier wire throughout, since it stands up under the strain better, requiring less attention.

While the plain iron wire is more commonly used than the galvanized, it is a question whether the greater cost of the latter will not be justified by its longer life.

In stapling the wires to the posts rather heavy and long staples are best, those of No. 10 wire, one and three-quarter inches long, being preferable unless the posts are of very hard wood, in which case one and one-half inches is long enough. They should never be driven in tightly, but should be left loose enough to allow of the wire being pulled through them readily,

since it will be necessary to tighten the wires each spring to take up the slack wire caused by the stretching of the wires and the give from the posts. The wires should also never be stapled to the end posts, but each wire should be wound around the post once and then twisted back upon itself, so that it can be easily loosened at the annual spring tightening of the wires.

An ordinary wire stretcher, such as is used in building wire fences, is better than any of the patent devices for tightening the wires.

FIG. 188.—A poor type of bracing. These braces are too short and are placed so as to make too acute an angle with the end posts. Such bracing is sure to lift the posts.

Vase or goblet-pruned vines are commonly found in California and other regions where the European varieties are grown. Trellises are used with only a few varieties. A heavy trunk is developed by first pruning to a height of 15 to 25 inches. The second year, one cane is allowed to grow and is pruned to form branches during the summer. This is cut back to form the first permanent spur or finger. Year by year other spurs are formed and the number gradually increased to suit the strength of the plant.

Muscadine grapes for home use are found trained on arbors where they are too often neglected. They thrive best when systematically pruned just after the leaves fall. Two forms of wire trellis are recommended by growers: (1) The three-wire trellis with wires at heights of about 2, 3, and 4 feet, the Kniffin system of pruning being used. (2) A canopy trellis of three wires; the pruning is of the umbrella form.

QUESTIONS

1. How does pruning the grape compare with that of other fruits?
2. What are the two important principles to keep in mind when pruning grapes?
3. Where do you find the clusters of grapes on a vine?
4. Define a shoot; a cane; an arm; a trunk.
5. How would you prune a grape vine the first and second seasons?
6. Describe and compare the spur and renewal systems of pruning.
7. Describe the High Renewal system of pruning and training.
8. What are the advantages and disadvantages of this system?
9. Describe the Horizontal Arm Spur system of pruning and training the grape.
10. What are the advantages and disadvantages of this system?
11. Describe the Four-cane Kniffin system of pruning and training the grape.
12. Is this a good system?
13. What are the objections to it?
14. Discuss the Two-cane Kniffin system.
15. Discuss the Umbrella system.
16. Describe the Munson system of pruning and training the grape. Where is this system most useful?
17. Describe the making of a vineyard trellis.
18. Which of the systems described would you select for your own vineyard? Why?

CHAPTER XXXV

INSECTS, DISEASES AND SPRAYING OF GRAPES

Grapes have their full share of insects and diseases, and many of them are of the first magnitude. Books on economic entomology catalog as high as twenty-five or thirty insects which are likely to be more or less troublesome in the vineyard; while the list of those plant diseases which are likely to be found attacking the grape, though less extensive than that of insects, runs up to ten or a dozen.

From this list it may be in order to select four or five of the most important insects for discussion in this chapter, though in some sections many of those omitted may be of more importance than the ones selected.

The Grape Root-worm.—To begin at the bottom we may start with the grape root-worm, which is perhaps as common and destructive in grape sections as any one insect, losses from its ravages having been estimated as high as two million dollars and over for a single season.

The adult beetle is a small, grayish-brown insect about a quarter of an inch in length. It emerges from its cell in the earth, where it has passed the winter, from the latter part of June to well on towards the last of July. The insects begin feeding on the grape leaves at once, and in bad cases continue until the leaves are almost entirely consumed. In less severe outbreaks they merely eat long, somewhat connected holes in the leaves, but in any case the function of the leaves is seriously affected. In a short time the females begin depositing their cylindrical, yellowish-white eggs under the loose, shreddy bark of the trunk and old canes. In the course of a week or two the eggs begin to hatch and the young grubs drop to the ground and work their way down to the roots of the vines, where they at once begin feeding, eating the small, fibrous roots first, but later attacking even the main roots in which they eat out holes and burrows. In badly infested vines the root system is almost entirely destroyed, so that the leaves fall and the fruit shrivels

and eventually drops. In less severe cases the vine may merely take on a sickly appearance, but even here the value of the crop is seriously lessened. Attacking, as this insect does, both the leaves and the roots it can ruin a fine vineyard in a very short time.

Remedies for Root-worm.—By far the most efficient, the cheapest, and most satisfactory method of controlling this insect is through the use of poisons to kill the adult insects while they are feeding on the foliage. Arsenate of lead, at the rate of three pounds of paste or one and one-half pounds of powder per fifty gallons of water, sprayed very thoroughly upon the vines as soon as the first insects begin to appear, is the most common line of treatment. It should be done very thoroughly, indeed, as any spraying must to be effective, and the upper surface of the leaves, particularly on the growing shoots, should be especially well sprayed, since this is where the bulk of the feeding is done. Sweetening the spray adds to its palatability for this insect and it is a common practice to add a gallon of molasses to each fifty gallons of spray.

In addition to attacking the adult stage in this way there is also an opportunity to combat the insect in the pupal stage. The insect winters over, for the most part, in the larval stage in little cells in the soil and here it transforms to the pupal stage early in June. If these cells can be broken up by stirring the soil many of the insects will be killed. As already suggested, it is the custom in many vineyards to throw a furrow towards the row at the last of the cultivation season. In this way the insects are induced to form their cells in the soil much higher up where they can be more readily destroyed in cultivation. It is the custom to give a very thorough stirring of the soil along the rows about the middle of June (or earlier in southern states), using both the cultivator and the hand hoe to make sure that all the cells possible are broken up.

These two lines of treatment will usually keep the root-worm in check, provided that the vineyard is well cared for in other ways.

Rose Chafer.—Another most troublesome insect, particularly

in sections where the soil is light and sandy, is the rose chafer or rose bug. This is a good-sized insect, perhaps half an inch long, light grayish brown above and greenish below, with long straggling legs and generally clumsy appearance. They attack many other plants besides the grape, and usually appear very suddenly and often in countless numbers. In bad attacks they are so numerous it is easy (though not pleasant) to collect a handful of them from a single small twig. They feed on the blossoms and young fruit first, but soon attack the foliage, leaving it badly shredded and sometimes almost entirely destroyed. The eggs are deposited in the soil, preferably the lighter soils, and on hatching the young grubs feed on the roots of grasses and other plants. They winter over as larva and enter the pupa stage in little earthen cells, about four or five inches below the surface of the soil, in May or June, emerging about a month later as adults.

Remedies Against Rose Chafer.—This is one of the most difficult insects to fight. They do not like poison and will avoid eating it if possible. Removing them by hand and destroying them is often recommended, but is altogether too expensive to be commercially practicable. Spraying as just recommended for the root-worm seems to be the most satisfactory treatment, but more poison must be used; 8 to 10 pounds of arsenate of lead paste or 4 to 5 pounds of powdered arsenate of lead in 50 gallons of water will be found none too much, and the molasses should always be added to make it more palatable. Thorough and rather deep cultivation of the soil while the insects are in the pupa stage is also effective. The avoidance of very light soils is helpful, since the insect is rarely troublesome on the heavier soils.

Grape Leaf-hopper.—A third insect attacking the leaves is the leaf-hopper. This is a small, yellowish-white insect, very active, hopping or flying readily when disturbed. It feeds on the under surface of the leaves almost entirely, puncturing the tissues and sucking the juice, which causes the leaves to turn light color at first, in the spots attacked, and later the entire leaf turns brown and may fall.

The insects winter over as adults in grass or trash, either about the vineyard or in nearby fields, coming out early in the spring to feed on any foliage that may be available, and migrating to the vineyard again when the grape leaves are well expanded. This fact suggests one method of attack, namely, clearing up all such places either in or near the vineyard, fence corners, brush patches, and weedy or grassy spots.

Spraying for Leaf-hoppers.—Since it is a sucking insect it cannot be killed by stomach poisons, but must be attacked with some contact poison. Nicotine sulfate at the rate of one part to 1000 of water seems to be best. This must be applied very thoroughly, as only those insects which are thoroughly wet will be killed. A rather coarse spray is most effective, and especial attention should be given to reaching the under surface of the leaves.

Grape Berry Moth.—An insect which is frequently very destructive to the fruit of the grape is the berry moth, a little brownish moth about a half inch from tip to tip of wings. The insect winters over in the pupa stage in a cocoon attached to the decaying leaves in the vineyard. From this cocoon the adults emerge in the spring and lay their eggs on or near the blossom clusters. These soon hatch and the larvæ feed on the blossom and buds, making a slight web among the blossoms. This first brood is rarely a large one and does not attract much attention, though each insect does much more damage than the later broods, since they confine their attention to the blossoms and small berries and destroy a much larger number per insect than is the case with later broods when the berries are much larger. The most abundant brood is the second one, but there is also a third and smaller brood in the late summer and autumn. The second and third broods pupate in peculiar little cocoons attached to the leaves, or sometimes inside the berries.

Poisoning the Berry Moth.—Spraying is the only effective means of attacking this insect, and the first brood is by all means the best "point of attack." Arsenate of lead at the rate of three pounds of paste or one and one-half pounds of powder to fifty gallons of water is the most satisfactory material to use.

The first application should be made about the time the fruit sets, a second one ten days later; and in bad cases, a third, ten days after the second. The spraying should be very thorough, using a nozzle giving a fine spray and a pump furnishing a high pressure (Fig. 189).

Grape Phylloxera.—This insect is a very bad form of the plant louse. The varieties of European grapes are most subject to attack, but some varieties of *labrusca* are also attacked. The root-attacking lice gather in great numbers, suck juices, cause

FIG. 189.—Barrel pump equipped for spraying in vineyard.

nodules to form, and death of the vines usually follows. The only successful remedy is to grow varieties subject to attack on stocks of resistant species. Varieties of Sand Grape (*rupestris*) and the River Grape (*riparia*) are best for use as stocks.

DISEASES OF THE GRAPE

Black Rot.—Turning now to fungous diseases we find the list headed, so far as destruction is concerned, by the black rot, which is so serious an enemy that it has driven the vineyard industry out of some sections altogether, and is always a dreaded enemy in any grape-growing region.

It attacks the young shoots, the leaves, tendrils, and fruit, but is far more conspicuous on the fruit than elsewhere. The disease winters over on any of the diseased tissues of the previous season, but especially on the mummied fruit, and usually makes its appearance first on the leaves. It appears here as brownish spots, roughly circular in outline, which in time develop blackish margins and which may, in bad attacks, often coalesce, forming larger, irregular patches. On the canes, tendrils, leaf stalks, and veins the disease appears as small sunken areas.

Soon after its appearance on the leaves it will be found on the fruit, appearing first as a minute spot, but spreading very rapidly until the whole berry is affected. As the disease progresses on the berry the skin remains intact, but the berry shrivels and in a short time becomes the dry, hard, mummied fruit so characteristic of this disease.

Black rot is very greatly influenced by the weather; a period of rains, with warm, muggy spells intervening, is particularly favorable to it, while dry weather is likely to check it.

Fighting Black Rot.—Several methods of attack are advised in combating this disease. Some of the best are as follows:

1. Destroy all mummied fruit and as far as possible all other diseased tissues, cleaning up the vineyard very thoroughly after pruning and burning everything that is taken out.

2. Pull all shoots which tend to start about the base of the vines.

3. Plow early and carefully, so as to cover all berries or twigs which may not have been collected and burned.

4. Practice very thorough cultivation so as to keep down all weeds.

5. Spray the vineyard thoroughly with Bordeaux mixture, using the 4-4-40 formula and applying it as follows:

First spraying. Just as the buds are swelling in the spring, spraying the trellis as well as the vines.

Second spraying. Just before the blossoms open.

Third spraying. After the blossoms fall. A fourth and

sometimes a fifth application is made at intervals of about two weeks in the case of bad attacks.

Downy Mildew.—Second in importance among diseases may perhaps be placed the downy mildew, though in some sections and some seasons the powdery mildew is the more serious of the two.

Practically all of the green parts of the vine are liable to attack, but the disease is by far the most conspicuous on the leaves and the fruit. On the under side of the leaf the diseased areas appear first as irregular, yellowish spots which soon become covered by a velvety or downy growth which is the fruiting stage of the disease and which will be found, under a magnifying glass, to be made up of little stalks which arise from the diseased tissues beneath. On the upper surface of the leaf the diseased areas are yellowish at first and later may turn brown and die.

If the berries are attacked while young the disease appears as a grayish coating similar to that on the under surface of the leaves, and this has given rise to the name "gray rot" which is often applied to this disease. In case the berries are not attacked till they are more mature the diseased area is brownish in color and the disease is sometimes called the "brown rot" from this appearance. The berries, in either case, shrivel up but do not become dry and hard as is the case in black rot.

On the canes the appearance is much like that on the under surface of the leaves, and usually the areas are sunken.

Spraying as indicated for black rot will usually control this disease, the first two applications not being necessary, however, when this disease alone is to be combated.

As the disease passes the winter on the old leaves about the vineyard anything which can be done to get rid of these is probably helpful.

The powdery mildew differs from the downy in several particulars, but especially in that it attacks both surfaces of the leaves and that it is more superficial, not entering the tissues as deeply.

It attacks all parts of the vine above ground. On the leaves it shows first as whitish spots which on close examination appear

as though dusted with a white powder. The leaves take on a mottled appearance and later these spots may coalesce and a large part of the leaf become affected. The leaves are dwarfed in their growth and often distorted in shape, and the whole vine, if badly attacked, looks dwarfed and discouraged, and there is a distinctly moldly odor to it. Blossom clusters which are attacked fail to set fruit, young berries drop from the clusters, and older berries develop irregularly and unnaturally, or they may crack open, or brown spots may develop which later take on the characteristic whitish appearance of the disease.

Remedies for Powdery Mildew.—The fungus develops most rapidly in moist weather and a wet soil favors it, so that everything possible should be done to keep the vines dry and to give them plenty of light and air. With this in view the vines should be planted at good distances, trellises should be run in reference to winds, the slope of the land and the sun, so as to give the best ventilation. Methods of pruning and training should be such as to distribute the growing shoots well, and all trees which might shade the vineyard should be removed.

Spraying as outlined for black rot will usually keep this disease in check, and this is generally all that is attempted. But dry sulfur is more effective than Bordeaux, and in serious outbreaks it is usually either substituted for Bordeaux or the vines are dusted with sulfur in addition to being sprayed with Bordeaux.

If sulfur alone is used the first dusting is given when the shoots have reached a length of six or eight inches, a second one about blossoming time, and others at intervals of a few days to two weeks, depending on the weather (whether dry or rainy), until five or six applications have been given.

Anthracnose, or Bird's Eye Rot as it is sometimes called, attacks all parts of the vine, but is most common and conspicuous on the fruit and the shoots. On the shoots it produces long sunken areas or cankers, which may girdle the stem but usually do not. Later the centers of these cankers turn grayish and the wood underneath takes on a burned appearance. On the fruit the disease produces a peculiar round spot, dark brown

in color with a whitish center and a dark border which may have a red line running through it. In time the fruit either becomes distorted and cracks open, or it may be killed entirely, drying out and becoming mummied.

Spraying as for black rot will aid greatly in controlling the disease, but the following additional points are recommended: First, exercise great care to prune out and destroy all affected canes. Second, use a dormant spray on the vines. This is most commonly lime-sulfur at the rate of one gallon of the concentrated to eight gallons of water, though some other sprays are used.

Necrosis.—One more disease may perhaps be included here, partly because of its importance and partly because it is so different from those already discussed. This is necrosis or dead-arm. All parts of the vine except the root are affected, but it is most serious on the arms or trunks because when these are killed the whole vine or half the vine, as the case may be, is destroyed. On the canes the disease shows as small brown or blackish spots, more or less sunken, which may be numerous enough to cover most of the surface. Diseased berries are affected like black rot, showing first as a rot and later becoming mummied. But when the disease is on the trunk or arm its effect is most noticeable. In this case the vine may fail to leaf out in the spring, having died during the winter; or it may leaf out and then the leaves wither and die; or in less severe attacks the leaves may be merely dwarfed or unhealthy in appearance; or at times the vine may be apparently normal up to midsummer and then the leaves and fruit may shrivel and die.

Control of Necrosis.—In attempting to control this disease the principal line of attack lies in destroying diseased vines or parts of vines. Everything possible should be done to locate such vines. In the spring pruning all suspicious vines should be pulled out and destroyed, or less severe cases may be cut back to the ground; or, if it is merely an arm, they may be cut back to the main trunk and renewed. Vines which have shown any indications of the disease during the summer should be carefully marked, and when the pruning is done should be examined with

especial care, and either severely pruned or removed altogether.

Since it is thought that the disease may be carried by pruning tools, care should be taken to use special tools for working on diseased wood or else to disinfect before using them on healthy wood.

Spraying as for black rot is of decided assistance in holding this disease in check.

With proper care along the above lines the vineyard may be kept free from the disease, or one which has become affected may be entirely freed from the disease.

QUESTIONS

1. Describe the grape root worm, its life history and control.
2. Describe the rose chafer. What remedies would you use for it?
3. Have you had any experience with the grape leaf-hopper? Tell all you can about it.
4. Discuss the grape berry moth.
5. Describe the phylloxera. Is it troublesome in the United States? Where is it serious?
6. Discuss the black-rot of the grape.
7. Describe the downy mildew. How would you control it?
8. How does the powdery mildew differ from the downy?
9. What is grape anthracnose? How can it be controlled?
10. What is necrosis in grapes? How can it be controlled?
11. Which of these diseases of the grape have you seen? Of the insects?

CHAPTER XXXVI

HARVESTING AND MARKETING GRAPES

The most interesting part of grape growing, whether it be commercial or amateur, is the harvest time. Then, in a comparatively brief time, one reaps the rewards for his labor, or pays the penalty for his neglect.

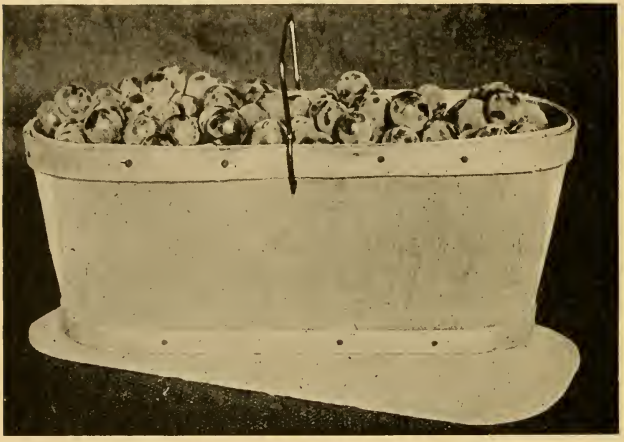

Fig. 190.—The Climax grape basket ready for covering. This basket is in almost universal use as a package for grapes.

A fair crop may be expected from the vineyard the third year if it has made a good growth, and a better one the fourth year, while by the fifth year the vineyard is usually in full bearing.

And since so much depends on this brief period, everything possible should be done in advance to make the work of that period run as smoothly as may be. It is a most excellent manager who can prepare with sufficient thoroughness so that baskets and shears and trays and boxes and wagons and pickers and

packing sheds, and numerous other things, may all be on hand or arranged for in advance.

The ordering of packages is the item which needs to be provided for the longest beforehand. Prices are almost certain to advance as the season advances, and even if they do not it is safer and better to have the packages on hand.

Climax Grape Baskets.—Packages differ considerably, according to the locality and according to the market to which one caters; but by far the most common package is the so-called Climax basket (Figs. 190 and 191). Two sizes of these are in general use, the 4-pound size for the earlier or higher-priced varieties, and the 8-pound size for the standard and lower-priced varieties. These baskets have much to commend them from almost every standpoint. They are well known, attractive, and convenient to carry; they hold a quantity of fruit which is about right for the average family and for which the grower can charge a higher price per pound and still find a ready sale than he could for larger packages. They pack together well whether it be in loading onto a wagon, in packing a few baskets together for an express shipment (Fig. 191), or in loading a car. In any of these cases two baskets are placed side by side at the bottom and the next two on top of these, with the handles of the bottom pair projecting up between the pair above, and so on.

FIG. 191.—A ten-basket package of Climax baskets (Fig. 190) ready for shipment by express.

Larger Packages.—In sections where grapes are sold for grape-juice (and this is coming to be of more and more importance), or where they are used for wine, some type of box or tray is used instead of a basket. The most common receptacle

for this purpose is a tray holding from 20 to 30 pounds of fruit.

In some sections for local trade, and in the California district for many of the grapes sold for table use, a flat till basket without handles is used. In case these baskets are to be shipped they are crated, usually four baskets to a crate. For strictly local trade they can be filled considerably above the basket and make a very attractive package (Fig. 192).

For the cheaper grades of grapes which are sold locally to housewives, for either jelly or grape juice, the ordinary 14-

FIG. 192.—The till basket packed for strictly local trade. Such a package will always attract buyers.

quart peach basket is often used (Fig. 193). It will hold about 25 pounds and makes a cheap, convenient, and generally satisfactory package. It is not so satisfactory for shipment and is not much used for that purpose, holding too large a quantity of fruit to carry well.

The proper condition of ripeness for picking is much more difficult to decide upon in the case of grapes than with most other fruits. In the first place, nearly all varieties color long before they are ripe, some varieties as long as three or four weeks. In the second place, grapes do not ripen up and improve in quality after they are picked as many other fruits do;

the quality must be there when the fruit is cut from the vines or there never is any quality. For these reasons the question of whether the fruit is ripe enough to pick must be settled by the foreman and not left to the pickers. With most varieties the stems of the clusters will turn brown and shrivel a little before they are ripe enough to pick. This indication, with some testing of the quality by eating a few berries, will decide the question of when to begin picking.

If this precaution is not taken a great many grapes will be harvested before they have developed any quality, and some of the early varieties have little enough quality at best. Moreover, there is always a temptation to cut the early varieties quickly and get them on the market while the price is high. The result of these two factors (yielding to this temptation to get ahead of one's competitors and lack of care in investigating the ripeness of the fruit) is that many grapes go on the market with so little quality that they spoil the demand for later and better varieties.

FIG. 193.—The 14-quart peach basket used for the cheaper grades of grapes which are to be sold locally for jelly or grape juice.

Grapes should always be dry when they are picked. There should be little deviation from this rule except for very local markets where they are to be used almost immediately. The clusters should be handled just as little as possible. These two points should be insisted upon. With such a delicate, tender fruit as grapes, any bruising or dampness is likely to start decay and ruin the whole package.

Avoid Handling Berries.—The picker takes hold of the cluster by the stem and with a pair of shears cuts the stem and then lays the cluster on the tray or in the basket. In this way the berries are not touched or, at most, are touched very little.

and the bloom is therefore not disturbed. If the grapes are black and the bloom is heavy this will make a great difference in the attractiveness of the fruit, for such grapes will show every spot where they have been touched by the fingers, or the shears or the basket. Clusters which have been handled much are not nearly so beautiful as those with the bloom intact.

Picking and Packing.—In the harvesting of the fruit two general methods are in vogue. In one case the grapes are cut and packed into baskets in the vineyard ready for market, and in the other they are cut and placed in trays and are taken to the packing house to be later packed into baskets. Several advantages are claimed for each method. The principal advantage of the field packing is that it lessens the expense, and this is such an important advantage that where the crop of grapes is well grown, with few defective berries that need to be cut out, the method is very largely used and in some sections is almost universal.

The advantages claimed for packing in the sorting house are: (1) The more skillful operators may be put on that particular operation and so get better work. (2) It allows of removing the defective berries which cannot so well be done in the field. (3) The poor clusters can better be separated from the good ones and put into different packages to be used for jelly, juice, or wine. (4) After the fruit has wilted it packs into the baskets better and with less danger of breaking either clusters or berries.

Where the grapes are packed in the vineyard a stand is usually provided of a convenient height, so that the pickers do not have to stoop to reach it, and on this the baskets are placed for filling.

A pair of shears is used for cutting the grapes (Fig. 194) and the baskets are filled well above the edge, placing the clusters usually in two layers, though this will depend somewhat on the variety. As the baskets are filled they are placed on the ground under the vines where they will be out of the sun and are later gathered up and taken to the packing house. For this purpose a wagon with good springs is absolutely imperative. Many a

ton of beautiful grapes has been ruined in hauling from the vineyard to the packing house, though the distance might be only a few rods. Racks are provided on the wagon so that several tiers of baskets may be hauled at one load.

Care in Packing.—The packing, whether done in the vineyard or at the packing house, should be done with the greatest care in order to keep the baskets clean and attractive. A few broken grapes on the tray or rack where the packing is being done may completely spoil the appearance of the neatest and most handsome package made.

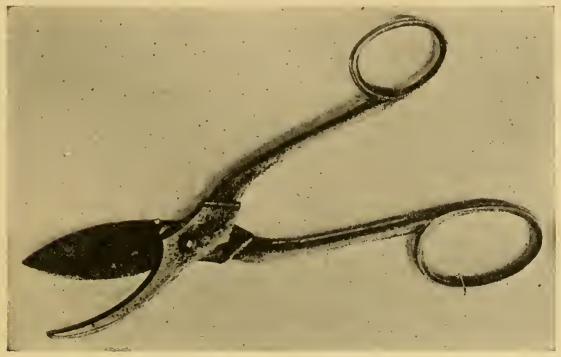

FIG. 194.—Type of scissors used in cutting grapes. The curving jaw prevents the stem from slipping.

Settling and Covering.—At the packing house the baskets are stored for a day or more to allow the fruit to wilt and to settle down more or less in the baskets. As a result of this combined wilting and settling it is possible to press the grapes down low enough so that the covers (which are merely flat pieces of thin board cut to the right shape) can be slipped over the baskets and fastened in place by two staples.

If the grapes are to be packed at the packing house they are cut as above described and placed upon trays which are then hauled to the packing house, using the same precautions to keep them out of the sun and dust, and not to bruise them in hauling.

FIG. 195.—Harvesting grapes in trays. This type of tray is only used in handling grapes for local trade.

FIG. 196.—Rack used in carrying grapes from the vineyard to the nearby packing house.

These trays are then piled up in tiers in the store-rooms, and the grapes are allowed to wilt for at least twenty-four hours, and sometimes for several days. This depends somewhat on the variety, it being possible to hold those sorts which do not shell badly longer than those which do; it also depends on the weather, dry weather naturally hastening the process, and on the ventilation and other conditions of the storage house.

Where the vineyard is located close to the storage house, or for smaller operations where only a comparatively few baskets of grapes are harvested at a time, a hand rack is often used on which the trays are placed as the grapes are cut (Fig. 195) and with which they are brought into the packing house (Fig. 196).

Taking to Market.—From the packing house the grapes go to market under various conditions. From the larger vineyard sections they are shipped out by the carload, using refrigerator cars. For more local markets they may go by team direct to the wholesale market; while for still more local trade they are taken direct to the grocery or fruit store which is to sell them to the consumer.

QUESTIONS

1. State the relation between age of vines and yield in young vineyards of your region.
2. Give your judgment on the preparation for harvest in some vineyards you have seen.
3. Where are grape containers to be purchased? Give some addresses or tell how to get them.
4. Have you seen Climax baskets of fruit handled by express men? Describe the handling and stacking.
5. Describe the different grape packages you have seen. Give adaptations and advantages of each.
6. How would you judge the proper condition of ripeness for picking the grape crop?
7. What cautions and directions would you give to a gang of pickers?
8. Which of the plans of picking and packing have you seen? Which are best? Why?
9. What are some causes of unclean or otherwise unattractive packages of grapes you have seen?
10. What is the value of wilting before covering?
11. What are the methods of transporting to market? Give your own observations if possible.

APPENDIX

PROJECTS, PRACTICE WORK, FIELD AND LABORATORY EXERCISES

Since the writer has hoped that this volume might be useful to his fellow-teachers of fruit-growing, it seems worth while to insert here a brief discussion of fruit practice work in general, and of some specific exercises which might be used in connection with the fruits discussed in this volume.

There is no question as to the value of practice work in connection with fruit-growing courses (or almost any other courses, for that matter). Some subjects can be taught better than others without the help of practical work; but the teacher who attempts to train his students in pruning grapes or raspberries, or to teach the methods of fruit bearing in these or other fruits, without taking them into the plantations, and without giving them an opportunity to perform the actual work, certainly has a difficult task to accomplish and cannot hope to be entirely successful.

Six Important Points.—In the writer's experience in handling practice work six points stand out as especially important. These are:

1. **Timely Exercises.**—Have the exercises timely; have them fit into the plan of the course and the season of the year. This is by far the most difficult condition to meet; in fact, it cannot be met. Any solution of the matter will be a compromise, and frequently a rather disappointing compromise. But the teacher ought to give to it all the time and brains and initiative that he has at his command.

Take, for example, the practical work which might be given for a course on raspberry growing. The logical way to develop such a course would be to start with the propagation of the raspberry, and go on through the establishing and care of the plantation, and end with the picking and marketing of the fruit. If one wishes to give ten kinds of practice work with such a course,

the subject of the exercise and the date at which it ought to be given would be about as follows:

Raspberry Culture

Exercise	Date
1. Propagation:	
a. Root cuttings	November
b. Rooted tips	August
2. Preparing land and laying out bed	April
3. Setting the plants	April or May
4. Culture	May, June and July
5. Fertilizing	May
6. Cutting back or topping the canes	June
7. Pruning	March
8. Trellis and training	April
9. Removing old canes	August
10. Picking and marketing	July

If we examine the left hand column of the table the development of the plan seems to be fairly rational, but the right hand column has absolutely no continuity. The only thing for the instructor to do under these conditions is to make his laboratory work as timely as possible and let it go at that; some of the exercises will have to be omitted; others will have to be given out of their natural order; a few will fit in where they really belong.

2. **Have Enough Practice.**—The second important point in fruit practice work is to have an abundance of work to do. This, of course, is merely a question of having large enough plantations to accommodate the classes which must be taught. But frequently this is by no means a simple matter, and very often it is entirely out of the question. When it is at all possible, however, the instructor should have a sufficiently large plantation at his command so that each student may do enough of each type of work to at least become aware of some of the problems he will have to meet and decide. If it is a question of pruning grapes on the four-cane Kniffin system he ought to prune enough vines so that he becomes reasonably expert in the work and so that he realizes that no two vines are exactly alike, and no

single vine looks exactly like the diagram he has seen in his text-book or on the blackboard. The importance of this point can hardly be overemphasized.

3. **Each Student Assigned His Project.**—The third point in making the work satisfactory is to secure the right attitude on the part of the students. Usually this is not at all difficult if the instructor understands his subject and his students, but it is a crucial point, and ought to be given the most careful consideration. One thing is absolutely essential to success on this point and that is to have the work so arranged that each student is definitely responsible for a certain part of it, for so many grape vines, or a definite length of raspberry or strawberry row. He conducts it as his own project. This is not saying that the average student is a shirk, but he takes more interest and pride in the work if he knows that he is to get the credit for good work, as well as the blame for poor work. Where no definite assignment of work is made it is impossible to locate the responsibility for either good or bad work. Moreover, if several types of work are to be done on the same plantation, each student ought to have the same section assigned to him for all of these different operations. For example, he ought to prune and tie up the same section in the vineyard, otherwise he may blame the other fellow for all the troubles he encounters in doing the tying.

4. **Planning in Advance.**—The fourth point in making laboratory work what it should be is to have it conducted in an orderly, practical and systematic manner. The instructor must, of course, know exactly how to do the work in hand—that goes without saying; but, in addition, he must plan out each exercise beforehand; for doing the work he must have modern apparatus such as is used on commercial plantations; and he must furnish the student with clear and concise yet explicit directions as to just what he is to do and not to do. In taking up any new piece of laboratory work it is very desirable to go over the whole process beforehand, just as will be done in the class, to make sure that there will be no hitches in the program. And, no matter how often the exercise may have been done in previous years, it is always desirable to check over the "order of exer-

cises " and see that each piece of apparatus is on hand and ready for use. No good teacher will omit this any more than he would omit preparing his lesson before going into class, no matter how often that same lesson might have been presented in the past.

5. **Proper Use of Note Books.**—The fifth point in laboratory work is to insist that each student give a full write-up in his note book of each exercise. This should be headed in his note book by the directions which have been given him by the instructor for the work, which should be followed by comments on the exercise as he has been able to carry it out. It is usually difficult to have these notes written up in a satisfactory manner, as most students will persist in merely giving back to the instructor what they have received from him. But any student is sure to be greatly helped if he sits down and records carefully his experiences and how they have varied from what might have been expected from the directions he received.

To carry out this point satisfactorily requires very frequent inspection of the note books by the instructor, and is something that it is very easy to neglect, but it is a crucial matter if the best results are to be secured.

6. **Questioning on Projects and Exercises.**—The sixth and last point is to have a full discussion of each practical exercise at the session of the class next following. The value of this needs no emphasis. The instructor should have definite questions in mind which he hoped and expected that the exercise would clear up for the student, and he should find out whether they have been cleared up or are still hazy.

Turning now from a discussion of laboratory work in general to a few specific examples of exercises which are likely to prove of value, the following will serve to illustrate the type of work. Each of the four exercises is supposed to occupy at least the time of one laboratory period, and the list given constitutes the directions given to each student. These directions may be dictated to the class at the beginning of the period or, better still, furnished in the form of a syllabus.

I. Digging and Setting Strawberry Plants.

A. Digging the Plants.

1. Take up 50 plants and shake the soil from the roots.
2. Remove *all* plants from the row and discard all but strong one-year plants. Notice the difference between one-year and two-year plants.
3. Remove all but two leaves from ten of the plants.
4. Bunch plants together and tie.
5. Trim the roots back to three inches.
6. Take up 50 plants with soil attached and place in boxes or trays.
7. Remove blossom buds from all plants.

B. Setting the Plants.

1. Dig holes for plants with hand, trowel or hoe.
2. In setting plants *without* soil attached, spread the roots out fan-shaped and place in the hole. Draw the soil over the roots and press it *very firmly* about them.
3. Have crown of plant just at surface of ground, neither too high nor too low. This is very important!
4. Press the soil down about the plant so firmly that it cannot be pulled up without exerting considerable force. Test this!
5. In setting plants with "sod" of soil open a hole that is ample to receive the plant, place the "sod" in the hole, and then pack the soil very firmly about it. Have soil in bottom of hole mellow, and be *sure* there are no air-spaces left under plant.
6. In all cases leave the soil well broken up on the surface to prevent evaporation of soil moisture.
7. Be very careful about mixing varieties.
8. Each student will set fifty plants in the matted-row system and fifty plants in hills.

Note—This exercise is designed for use where a "propagation bed" is available. In case the plants are taken from the fruiting bed, No. 2 under "Digging the plants" will of course have to be modified.

II. Pruning Raspberries and Blackberries.

1. Keep in mind the method of bearing fruit with these plants; on short shoots from buds on last year's wood.
2. Pruning consists of three steps:
   a. Heading back canes during their first season's growth at the height desired. Done when canes reach a few inches above that height, usually in June.

b. Heading in laterals, removing weak canes and heading back canes that were not topped in June. Done before beds start, usually in March or April.

c. Removing old canes after they have borne fruit. Done at any time from the time picking is finished up to the following spring.

3. Directions for pruning under sub-section (2*a*) above.
   a. Use a light pair of shears or the thumb and finger.
   b. Pinch or clip cane at the desired height, which is usually about three feet.
   c. Care should be exercised to do this at just the right time, otherwise growth of cane is wasted and the labor increased.
4. Directions for sub-section (2*b*) above.
   a. Use an ordinary pair of pruning shears such as is shown in Fig. 165.
   b. Take out all weak canes.
   c. Take out old and dead canes where this has not been done previously.
   d. Thin the remaining canes to *not over* five per hill or crown.
   e. Cut back the canes saved to good live wood.
   f. Shorten the lateral shoots to 12 to 15 inches.
   g. Keep the crowns as compact as possible by removing the outlying canes.

Note—These directions are for raspberries in hills. Other systems will of course necessitate some modifications.

5. Directions for pruning under sub-section (2*c*) above.
   a. For this work use a pair of long handled shears (such as is shown in Fig. 99) or a hook (such as shown in Fig. 114).
   b. Remove all the old canes that have fruited.
   c. Cut them off as close to the ground as possible.
   d. Be careful to damage the young canes as little as possible.
   e. In case the hook is used for the work, have the edge very sharp, so that it will not require a very vigorous pull to cut the canes, otherwise the roots will be disturbed.

III. Pruning Young Grape Vines.

A. Vines one year set.

1. Prune back to two buds, preferably on one cane, and that the lowest strong cane.

B. Vines two years set.

1. Prune weak vines same as one-year vines.
2. Prune strong vines to one cane three or four feet long.

C. Vines three years set.

1. For Four-cane Kniffin System.
   a. Save only the best long cane that is nearest the ground.
   b. Remove all laterals from it and cut it long enough to reach to the upper wire, 5½ ft., and along this wire 2½ ft.—8 ft. in all.
   c. In case a good T can be formed at about 5½ ft. from the ground, retain both branches and plan to form the permanent head of the vine.

Note—For other systems of training the directions for pruning three-year vines will be similar except for slight modifications due to the system. It is not possible, of course, to always have available a supply of one, two and three-year-old grape vines, but by making small additions to the vineyard each year a good range of vines of different ages can be maintained.

IV. Pruning Bearing Grape Vines in the Four-Cane Kniffin System.

1. Prune back each side of the vine, on each wire, to the first strong cane.
2. Cut back the canes saved to about five buds each on the lower wire and ten buds on the upper wire, cutting one-half inch beyond the last bud saved.
3. If weak canes are removed near the trunk, save one bud at the base of each to grow a cane for possible use next year.
4. Where no strong cane can be had, spur prune on the old arm.
5. Where the vine has two trunks get rid of one of them if possible.
6. If trunk is very old and crooked renew it if possible from a good cane which grew the previous year from near the ground.

Note—Similar directions can easily be given for all the other systems of training grapes with such slight modifications as may be made necessary by the difference in the systems.

Other Practice Work.—The above are merely suggestions as to laboratory and field exercises and projects. Many others will occur to the instructor who has had any experience at all in handling such work. Such practice should be repeated, if possible, until students show some skill in operations.

The list of exercises given under the imaginary course in raspberry culture, page 345, will, any one of them, furnish work for one or more laboratory periods.

For pupils that can do so, home projects in small fruit-growing should be outlined. These may run a season or more and may cover the vacation period.

Practice in spraying for insects and diseases, mulching,

renovation of old plantations, plant selection, systems of pruning, harvesting, sorting, packing, marketing, and using of products—all these and many other fruit operations will form a basis for valuable practice.

Improvement of Methods.—The instructor will find it of great value to sit down at his desk at once after a laboratory exercise has been given and consider whether improvements can be made in the plans or directions for the exercise the next time it is given.

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